The Engineer

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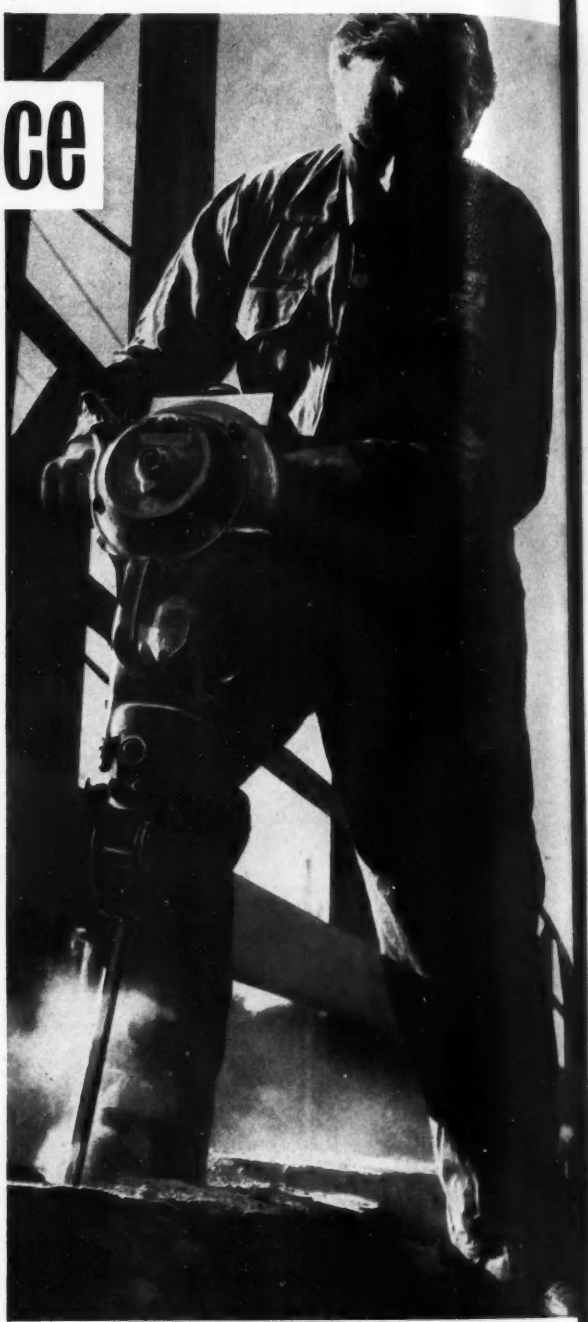

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THE ENGINEER

VOL. 202 No. 5259 NOVEMBER 9, 1956

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EUROPEAN FREE TRADE AREA

Late last week, having been urgently requested by the President of the Board of Trade to inform him about the reactions of industry to the projected negotiations about setting up a European Free Trade Area, the Federation of British Industries issued the text of a letter to him. That letter, which we reprint in full on page 663, does not express the views of the Federation. Instead it tabulates and comments upon the views of a large number of industrial associations. The projected negotiations arise out of the fact that negotiations are well advanced between Germany, France, Italy, Belgium, the Netherlands and Luxembourg, for the setting-up within a term of ten to fifteen years of a customs union. The Government's suggestion is that this country could be linked with that group, the "Messina" group of nations, through the setting-up of a Free Trade Area. There would be no tariffs between the U.K. and the Messina countries except upon food and drink and tobacco, the object of the exception being the retention of Imperial preferences of importance, reciprocally, to the U.K. and the Commonwealth. The associations within the F.B.I. were not actually asked to pronounce for or against the Free Trade Area project itself, but whether in principle they were in favour or opposed to the opening of negotiations with the Messina group. In fact, however, the President of the Board of Trade overlooked that his question could not really be answered without some study, by the associations, of the nature of the negotiations and there has naturally followed, to quote from the letter, "widespread dissatisfaction with the lack of time to consider these complex issues." Only the regional councils found a way round this difficulty (just as, perforce, we did in composing an editorial on the subject three weeks ago without knowledge of industrial reactions) by expressing the opinion, with one dissentient, that the United Kingdom could not afford not to enter into negotiations.

The remarkable fact which emerges from a study of Table II, accompanying the F.B.I. letter, is the paucity of outright opposition even within industries like textiles where opposition might have been expected to be strong. Table I reflects the same picture. But it is doubtful what significance should be assigned to the views expressed in this Table because only relatively few firms are included and because only those firms wishing to express individual opinions are included. So haphazard a sample, very possibly, does not reflect the true opinions of industrial firms as a whole. In the engineering and vehicles fields, returning to a consideration of Table II, it is seen that only two associations outrightly oppose, including, importantly, the Locomotive and Allied Manufacturers Association; though a number of other associations were unable to reach agreement in the time available. Exactly what significance should be assigned to the classification "opposed unless" it is not easy to say. The Federation has chosen to include associations holding these views amongst the opposition. But, in answering the precise question asked, that is whether in principle they approved or disapproved of negotiations, they can hardly be said to oppose them even though they may believe them unlikely to yield safeguards regarded as adequate and lack enthusiasm for the project itself. But if outright opposition is small, it is, at first glance, disturbing to see how much attention has been given to "safeguards." For, as we stressed three weeks ago, any substantial attempt to retain protection for particular industries would inevitably lead to a failure of the project. But upon examination, the "safeguards," with one exception, are found to relate, not to the retention of protective barriers to trade but to the removal of unfair barriers which would be restrictive to it. The one exception, that relating to strategic industries, constitutes obviously a matter of special difficulty. The discussion of "safe-

guards " in fact in no way implies opposition to the setting up of a Free Trade Area. It merely indicates, what the Messina countries have already, no doubt, discussed, that the creation of any kind of customs union is a complex matter which requires the co-operating nations progressively over the years to make adjustments to their internal policies so as to bring them into line. No doubt the President of the Board of Trade, even though he did not ask for it, will find it helpful to have placed before him a preliminary list of the kinds of matters that must be the subject of the projected negotiations. He has, we understand, already welcomed the offer of the Federation, expressed in its letter, to provide machinery for consultation with industry ; and, no doubt, in matters of detail affecting individual associations he will arrange for individual consultation.

The results of the F.B.I. survey apply, of course, only to manufacturing industry. The views of merchants and commercial firms might be different, though it does not seem very likely. As for the labour side, the T.U.C. also expressed its opinion last week. That opinion closely corresponds with the consensus of opinion which we think the F.B.I. document indicates to exist within industry. There would, the T.U.C. thinks, be serious economic and political disadvantages if the U.K. were to stand aloof from the European customs union, and negotiations ought to be entered upon with the object of working out safeguards under which a Free Trade Area might be set up. Naturally emphasis is laid upon safeguards of the interests of working people in the participating countries. There is no clarity yet as to whether industry and labour would actually favour the setting up of the projected Free Trade Area. But we think there is no doubt that the Government has been given a green light to go ahead with negotiations.

RURAL ENGINEERS

To say that scientific and technical progress continues apace may, in many circles, be dismissed as merely a platitude ! Yet, like many a platitude, it is a statement of fact. The pages of the technical press, the discourses and papers presented to the numerous learned societies, as well as radio talks and television programmes, regularly remind us that scientific and technical development never stands still. But we wonder sometimes if we are not apt to forget rather easily what things were like in the day when some of our modern technical methods and processes were scarcely " germs of ideas." We ourselves readily acknowledge that, frequently, when impressed by the speed and skill of current technical progress, at the back of our mind there is cherished the youthful recollection of the days spent within sight and sound of the village smithy. The smith, and his apprentice, were " mighty men." Deftly and accurately they fashioned horse shoes, forged a few odd chain links, made iron gates, and did the scores of miscellaneous repair jobs that reached them from the surrounding countryside. Their smith's hearth was kept aglow by hand-operated bellows, the highly polished cow's horn handle of which had its own peculiar lustre in the gloominess of a shop in which there was but one begrimed window. It would be rather wide of the mark to say that the erstwhile village smith was engaged in general engineering, yet as machines of one kind and another found their way into various rural industries, he was the man to whom their users first turned when problems of maintenance or repair arose. His achievements, without the guidance of text book or service manual, were often amazing !

Now the village smithy has been transformed into a " general engineering establishment." The wooden barn which used to house it has been replaced by a brick-built or prefabricated workshop ; a welding set and a few machine tools are essential items in its equipment. There are, we are informed, nearly 5000 of these establishments in this country, and an interesting record of some of their activities is presented in the latest annual report of the Rural Industries Bureau, a report which is aptly entitled *Hand and Machine in the Country*. This report emphasises that the rural engineer's workshop—like its predecessor the village smithy—is the local centre for serving the mechanical needs of the community. Its most important function, probably, is still to provide a maintenance and repair service to agriculture, an industry, of course, which places an increasing reliance on the satisfactory working of a large amount of machinery, and some of it very complex machinery. The modest resources and equipment of rural engineering workshops, however, are not always fully occupied with maintenance and repair work. They manufacture, on a limited batch production basis, many an article, or " improvised " spare part, that fills the immediate requirement of a harassed local customer. In addition, there are products of this kind, especially amongst farm implements, which have been conceived in a country workshop, and which, having proved their worth, have come to be included in the regular lines of the much larger manufacturing concerns. The Rural Industries Bureau certainly performs a valuable service in readily giving encouragement and advice to these country engineering workshops. In recent years particularly it has found that the rural craftsman has been anxious to discover ways of doing things more quickly and means for saving labour. He has shown himself to be thoroughly " productivity minded." As well as providing courses of group instruction for rural engineers, the Bureau deals with many requests involving the development of new machines or the adaptation of existing ones to perform work hitherto done by hand. Its experimental workshop is obviously kept very busy, and its technical officers spend a great deal of time making practical trials of new tools and equipment in order to assess their suitability and quality in relation to their use in country workshops. All these and the many other services performed by the Bureau undoubtedly lead to greater efficiency and economy in rural engineering workshops. And there is plenty of evidence that the majority of rural engineers are keenly aware of the need to be efficient and up to date in the prosecution of their business. Their business may be one whose light is often hid under a bushel ; they themselves may sometimes look a little enviously upon the research and production facilities which are part and parcel of the much larger establishments. Nevertheless, their work continues. It is work which still makes a worthwhile contribution to the standard and quality of the country's engineering industry.

The Engineer
100 Years Ago

(NOVEMBER 7, 1856)

" STEAM CULTURE VERSUS AMERICAN SLAVERY "

" What influence is steam culture likely to have upon the slave question of the United States of America ? To what extent can slave labour be supplanted by steam power ? Can steam, which has effected such great revolutions in the manufacturing and commercial worlds, produce similar results in the agriculture of the southern States of the Union. . . .

" The important question at issue is about to receive a practical solution in the island of Cuba. One of the largest landed proprietors of that country is now introducing steam-culture upon his Cuban estates, for the purpose of superseding horse and slave labour. Experience having taught him that slave labour was not only more expensive than free, but that it also increased the expense of horse labour—a lazy horseman always making a lazy horse—he, along with his engineer, lately visited this country, in the hopes of being able to abridge labour by steam machinery, and were not disappointed, for on seeing experiments made before the select Committee of the Board of Ordnance, in hauling heavy siege guns with one of the traction engines now in that department of the public service, they saw what steam could effect in the field, and accordingly gave orders to one of our large agricultural implement firms for a traction engine and other machinery. . . .

" We shall wait with much anxiety the result of the experiments about to be made at Havannah, and, if successful—as there is every reason to believe they will be—it would be contrary to all experience to suppose that our transatlantic cousins will not imitate so tempting an example ; for there is, perhaps, no country in the world that teems so much with inventive talent as the United States, or brings an equal amount of mechanical ingenuity to bear upon the productive resources of its soil."

A Seven Day Journal

Awards for Post-Graduate Study

THE MINISTRY OF EDUCATION and the Department of Scientific and Industrial Research have recently reviewed, in consultation with the committee of Vice-Chancellors and Principals of Universities, the present system of awards for post-graduate study in the United Kingdom. As a result, new arrangements have been announced this week. Competitive awards, to be known as "state studentships," will be offered annually by the Ministry of Education to students considered by their universities to be specially qualified for post-graduate study in arts subjects. Furthermore, from 1957–58, the Department of Scientific and Industrial Research will offer a considerably increased number of competitive post-graduate awards in science and technology. These awards, which will be tenable at technical colleges as well as at universities, will be available not only for training in research but also for advanced instructional courses lasting more than six months. The D.S.I.R. says there will be two kinds of award for which students having a good honours degree will be eligible; they are "research studentships" for post-graduate students seeking two or three years of supervised training in research, leading in most cases to a Doctorate of Philosophy, and "advanced course studentships." The courses to be included in the "advanced course studentship" scheme will cover a variety of subjects, including, for example, aircraft design, chemical engineering, applied electronics, soil mechanics and fuel technology. Awards will normally be made to graduates taking the courses immediately after having received their degrees, and it is expected that those who have already taken employment in industry will normally be supported by their employers.

Conservation of Land

THE third of the Institution of Civil Engineers' series of lectures on the conservation of natural resources was given on Thursday of last week by Professor L. Dudley Stamp; his subject was "The Conservation of Land." The Professor pointed out that contemporary town and country planning sprang, not from political ideology, but from physical necessity imposed by the scarcity of land in this country. He outlined the principles which should underlie planning of this kind, based on land classification and aiming at the optimum use of land. There was about 14 acres of land per head of the world population, he said; about 30 per cent of this could be considered usefully available. Just over an acre of good agricultural land was needed, on an average, to support one human being. In this country the corresponding areas available were about 1½ acres per head and 0·55 acre per head of fertile land. The best agricultural land had been established for many generations in this country, Professor Stamp pointed out, and was a valuable "capital" asset. He went on to classify the various uses of land and made some remarks of special interest to civil engineers. The "consumption" of land for such uses as airports and motor roads was essential, he said, but the American standard for motor roads, where as much as a square mile of land had been taken up by a cloverleaf junction, was too lavish. The Professor concluded by appealing to civil engineers to consider whether it would not be possible, with modern earth-moving plant, to help in the proper development of land conservation. Was it not possible, he asked, to think in terms of making soil? Not the "soil" of soil-mechanics, but agriculturally productive soil. And would it not be possible, he asked, to reclaim some of the coastal marshlands? Reclamation was carried out, here and there, for industry, but some of these coastal areas were especially suitable for agriculture, and the Professor suggested that modern engineering resources might be able to add 250,000 acres to our scarce resources of best-quality agricultural land.

London Airport

AIR MARSHAL SIR JOHN D'ALBIAC, addressing the Royal Aeronautical Society last Tuesday, described London Airport, of which he is commandant, as the finest in the world. The runways, he said, were sufficiently long for the jets at present in airline use—the "T.U. 104"—but would probably be extended to the West in the future. Other improvements in the facilities to which he looked forward were the transference of the Ground Controlled Approach from the runway in use to the control tower, and the provision of a "silo" to accommodate the multitude of parked cars. He pointed out that the journey from the airport to London was becoming slower, and favoured a spur from the existing railway as the solution. He also advocated that, on long-distance flights, all classes of seats should be bookable, to avoid a scramble from the terminus to the aeroplane. In his view, it was essential for electronics to be employed to ease the burden upon air traffic control officers: he regarded as wrong the existing situation where the choice of take-off runway was affected by the need to avoid noise over inhabited areas, and claimed that the designers should be required to limit noise levels.

Retirement of Dr. S. F. Dorey

AN announcement by Lloyd's Register of Shipping states that on December 31st, Dr. S. F. Dorey, F.R.S., its chief engineer surveyor, is to retire after thirty-seven years' service with the Society, twenty-three of which have been spent in his present office. Dr. Dorey, who served his engineering apprenticeship at the Royal Dockyard, Chatham, and received his academic training at King's College, Newcastle upon Tyne, joined Lloyd's Register in 1919, after serving as an Engineer Officer in the Royal Navy in the 1914–18 war. He served for five years as an engineer and ship surveyor at a number of outports before joining the London office and then six years later was appointed a principal surveyor. It was not long before he became chief engineer surveyor and since 1933, when he first occupied this important office, Dr. Dorey's activities in the engineering field have been many, and his advice has been requested by technical institutions all over the world. His distinguished services to engineering were recognised by the award of the C.B.E. in 1946, and his election as a Fellow of the Royal Society in 1948. He has been honoured by several of the engineering institutions in this country for many of the scientific papers which he has read before them, several of which have been largely responsible for amendments to regulations relating to material, machinery and engineering methods of construction. The Society's Engineering Research Department was introduced by Dr. Dorey and he was to a large extent responsible for the beginning of the Society's non-marine activities. Dr. Dorey is to be succeeded as chief engineer surveyor by his deputy, Mr. H. N. Pemberton, who joined the Society in 1930 after several years' service at sea.

Electrification of the Epping-Ongar Line

LONDON TRANSPORT has announced plans for the electrification of the Epping to Ongar section of the Central Line, at a cost of £100,000. At present Central Line tube trains run only as far as Epping, where passengers have to change to a steam-operated shuttle service for North Weald, Blake Hall and Ongar. When the proposed electrification is completed, in some twelve to eighteen months, this six miles long single track section of line will be worked by two-car tube trains. The electrification of this line was originally planned as part of the 1935–40 new works programme, and conductor rails are already installed or are on the site throughout most of the line. No track alterations are contemplated, and the work to be undertaken includes resignalling with standard colour light signals, the conversion of track circuiting from direct to alternating current, and the provision of safety precautions for the North Weald level-crossing, which will then be the only level-crossing on the electrified Underground system. The electrification of the Central Line to Epping was completed in 1949, when the section now to be electrified was taken over by London Transport from the Eastern Region.

Public Works and Municipal Services Congress and Exhibition

THE products of about three hundred and sixty firms are to be shown at the Public Works and Municipal Services Congress and Exhibition which opens at Olympia, London, on Monday next, November 12th, for six days. At this biennial exhibition there will be displayed a representative selection of the plant, machinery and materials now being used by public authorities and contractors engaged in municipal undertakings. Preliminary information received from a large number of the exhibitors indicates that whilst there is a certain amount of new equipment to be shown much of it follows familiar lines with improvements in detail to increase reliability, improve performance in service and widen the range of application. Visitors to the exhibition will have an opportunity to see how the capacity and operational speed of large equipment, particularly that of mobile construction, is steadily increasing. On the other hand, there is a noticeable increase in the number of small "one-operator" equipments designed to reduce the time and effort entailed in heavy manual work involved in handling, mixing and moving materials. The cost and difficulty in obtaining sufficient labour for municipal work is increasing rather than declining, and for this reason the wide range of labour-saving machines and equipment shown will be well worth careful study by all concerned with municipal undertakings and public works contracting. At the congress to be held in conjunction with the exhibition there will be presented some thirty papers on a diversity of subjects of interest to municipal engineers.

Time Study and Statistics

By A. W. SWAN, B.A.Sc., A.M.I.Mech.E.

No. II—(*Concluded from page* 611, *November 2nd*)

Analysis of Actual Examples of Rated Time-Studies

THE following section analyses rated time-studies which have been supplied with the full co-operation and interest of Courtaulds' Work-Study department. These studies are of manual operations which involve considerable dexterity and skill and which are usually short in element times. They were taken at a number of different mills in the ordinary course of work and not specially for the purpose of this paper. Standard jobs were taken except for one interesting case in which three women operators were studied on a difficult variation of a job which in the ordinary way is straightforward. The time-studies have been analysed as distribution curves of observed times, rated times (observed times × rating/80), and ratings, together with correlations of observed times with ratings.

Case 1 ; *Cleaning Returned Cone Tubes.*—Works A (Figs. 6 and 7).

This is a difficult and "finicky" hand operation.

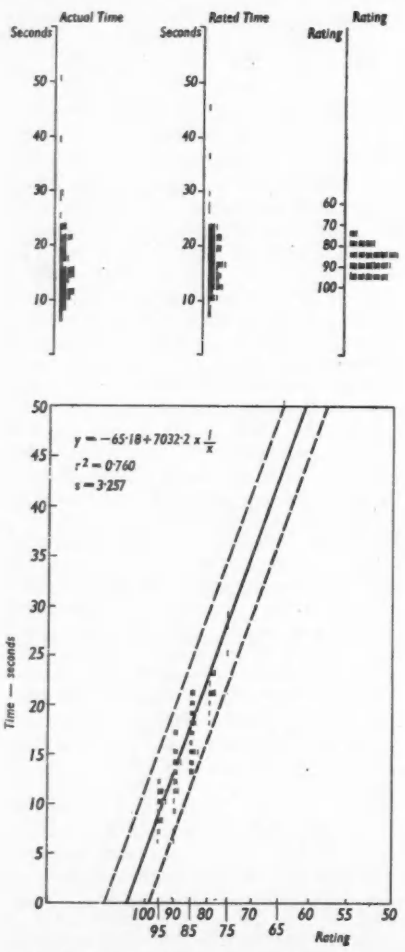
(1) *Observed Times.*—The distribution is rectangular suggesting that the job was not only difficult, but varied in difficulty and that the operator had not mastered the technique. Urgent need for method-study is indicated.

The deduction from the rectangular distribution of the actual times that method-study was required was proved to be correct. Unknown to the author of this paper, method-study has been carried out on this job since the time-study was made, resulting in suggestions for improved and simplified procedure which it is hoped will give better and more stable conditions.

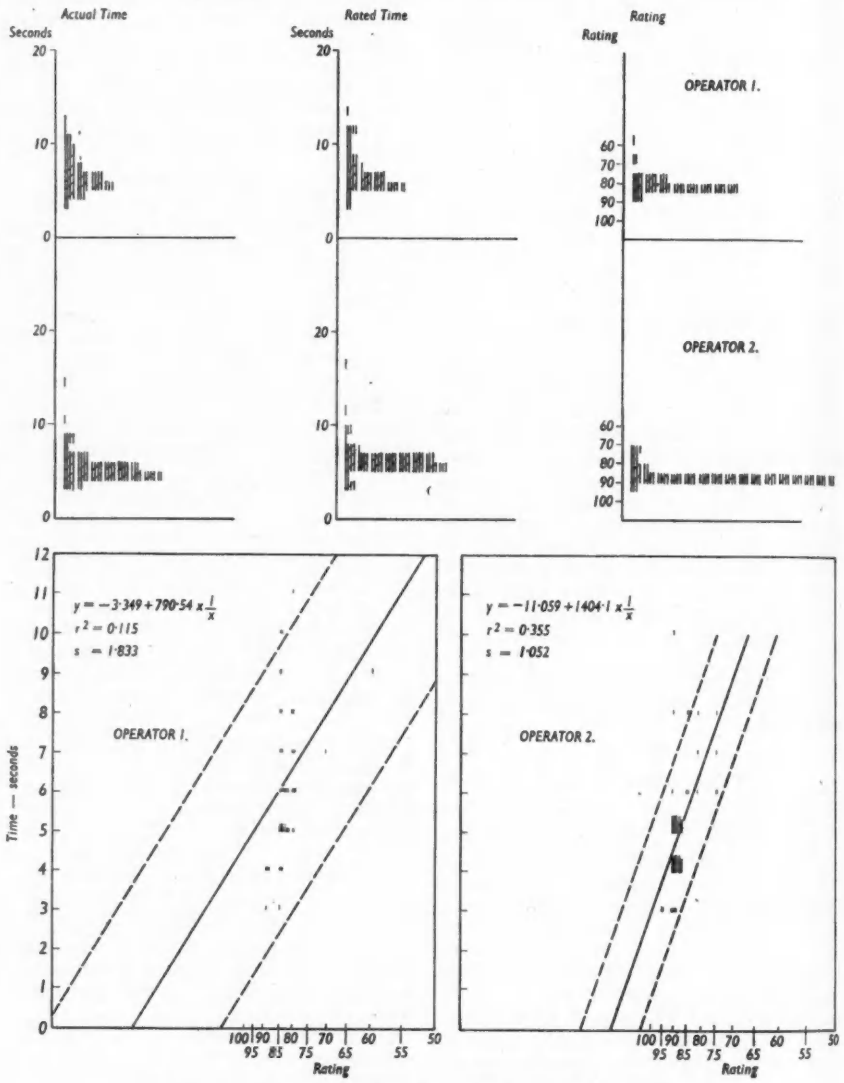
(2) *Rated Times.*—The distribution is rectangular similar to that for actual times, indicating that the time-study man recognised that the operator was having a difficult time and considered that she was working consistently with standard or better than standard effort.

(3) and (4) *Ratings.*—These are concentrated between 75 and 95, which tallies with the fact that the regression line is steep ; the time-study man tended to compress his range of ratings.

In general the rating had very little prac-



Figs. 6 and 7—Works A, cleaning returned cone tubes



Figs. 8, 9 and 10—Works B, cake wrapping, stockinette to former

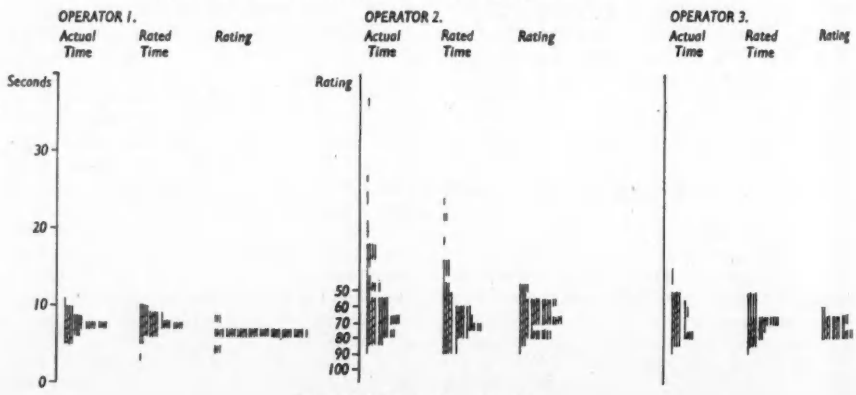


Fig. 11—Works C, coning, lace up

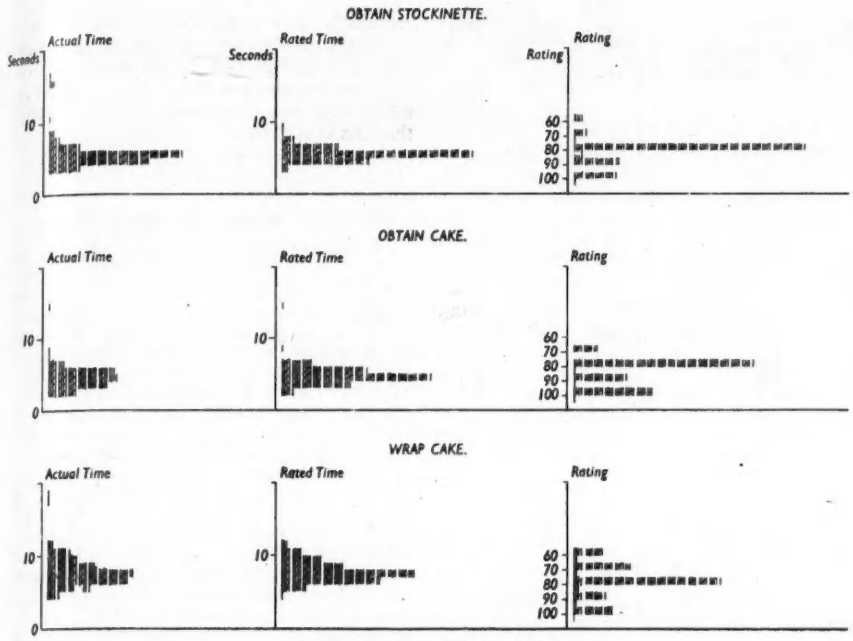
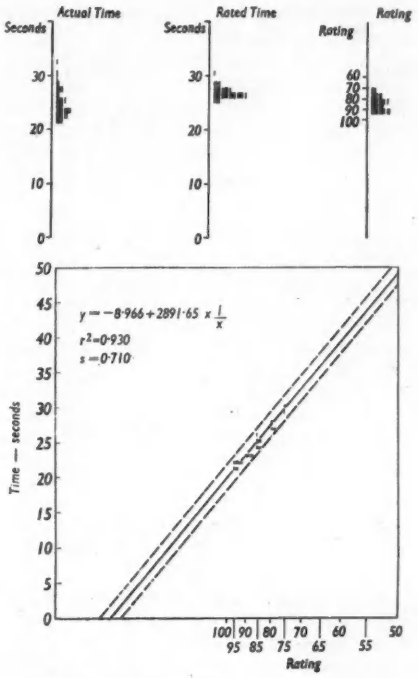


Fig. 12—Works C, cake wrapping



Figs. 13 and 14—Works A, wrapping, sealing

tical influence on the allowance for the job, since the rated time distribution is almost exactly that for the actual time.

Case 2; Cake Wrapping.—Works B (Figs. 8, 9, 10).

Stockinette to Former—Two Operators.

(1) *Observed Times.*—The distributions are slightly "skew" for both operators with a mean of 6·4 seconds for operator 1 and 4·9 seconds for operator 2. The times are uniform within a narrow range, with only an occasional longer time presumably caused by slight difficulty.

(2) *Rated Times.*—The distribution is almost identical with that for observed times. A contributory reason in this case for operator 1 is that most of the times observed are 5 seconds and the ratings are 85. As mentioned earlier, for 5 seconds, $5 \times \frac{85}{80} = 5 \cdot 3$ seconds, which is rounded off to 5 seconds (no change from observed time); rating therefore, makes no effective change in this instance. For operator 2, however, most of the ratings are at 90, just sufficient to alter the 4 and 5 seconds observed to 5 and 6 seconds rated. The distribution for rated times is, therefore, similar in shape to the observed with the mean moved upwards by about a second.

(3) *Regression.*—Regression diagrams are not shown since r^2 is not significant or barely significant indicating that the link between rating and observed time is extremely weak, and that the "difficulty" margin is correspondingly high.

Case 3; Cake Wrapping.—Works C (Fig. 12).

Stockinette to Former.

This study is shown as an example of the "easy number effect," in this case a subconscious stress on the round numbers 60, 70, 80, &c., with avoidance of the intermediate 65, 75, &c.

Case 4; Wrapping, Sealing and Packing 2½ lb Cones.—Works A (Figs. 13 and 14).

This is an interesting example of a very high correlation between observed time and ratings. It will be observed from Fig. 14 that r^2 has no less a value than 0·93, indicating that 93 per cent of the variation in the times is linked with rating, while $s = 0 \cdot 71$, a correspondingly low value. It will be observed also in this case from the distribution curve of ratings that there is no "easy

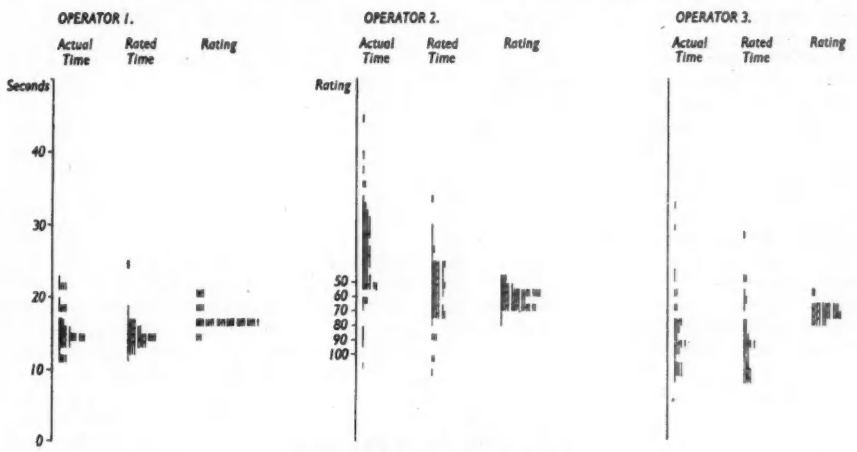
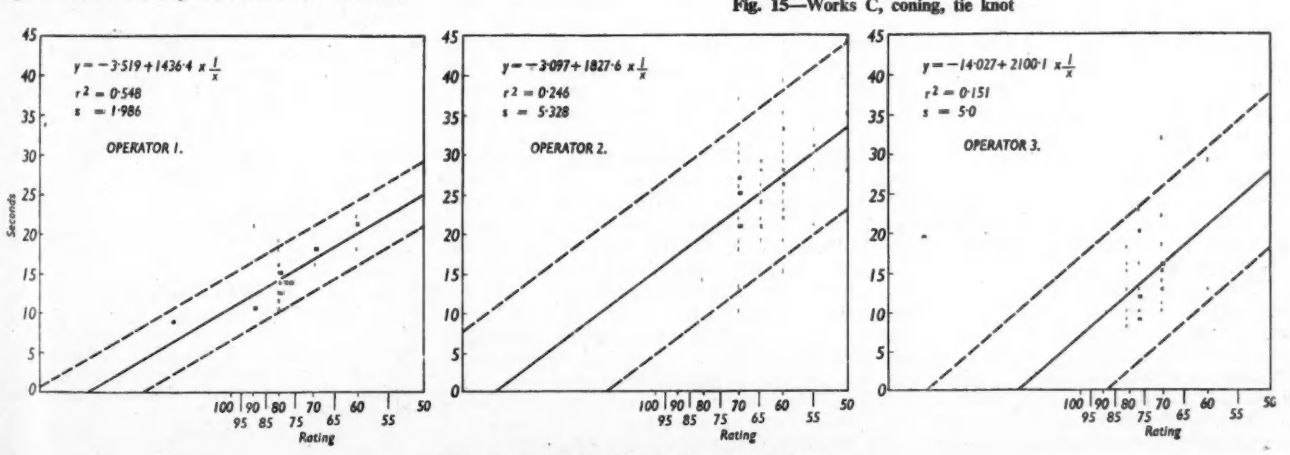


Fig. 15—Works C, coning, tie knot



Figs. 16, 17 and 18—Works C, coning, tie knot

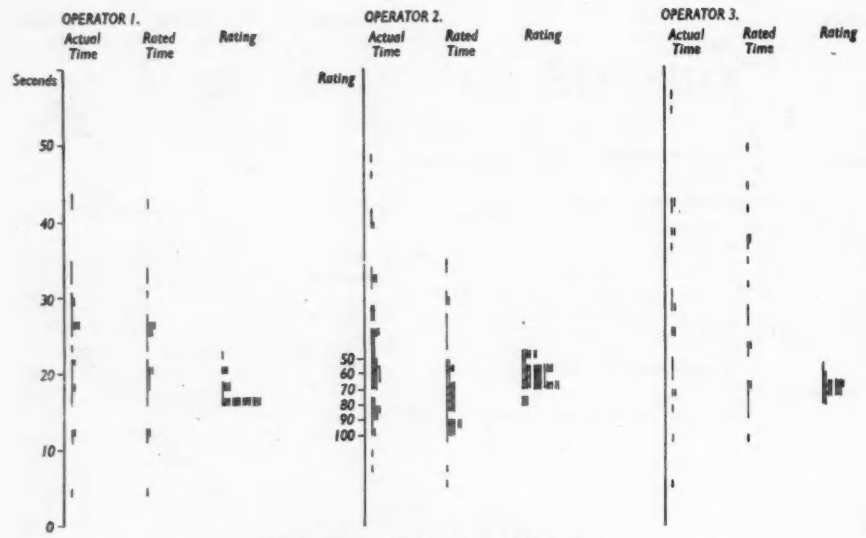


Fig. 19—Works C, coning, straighten cake

number effect," the distributions being smooth from 75 to 95, with little evidence of preference for either, 70, 80, 90, or 75, 85, 95.

Case 5 ; *Coning* 150/40 *Black*.—Works C. This was an intentional selection of a difficult job, in this case a variation on the standard job of coning. The main difficulty arises from the fact that the yarn being black is hard to see and therefore to handle.

Studies are shown of three out of five elements in the operation for three women operators who have proved themselves in ordinary work to be experienced and conscientious and for whom, therefore, long element times can normally be attributed to difficulty rather than to slow working.

(*a*) *Lace Up*.—Fig. 11.

(1) *Observed Times*.—From the narrow symmetrical distribution for operators 1 and 3 it is evident that they have overcome difficulties and settled down to routine. Operator 2 has apparently almost reached this stage but has occasional difficulties.

(2) *Rated Times*.—For all the operators distributions are similar to those for observed times. The average for operator 2 is slightly higher than for 1 and 3, but the mode is about the same.

(3) *Ratings*.—These are concentrated on eighty for 1, spread from sixty to ninety for 2, and are concentrated from seventy to eighty for 3.

(4) *Regression*.—r^2 is not significant for operators 1 and 3 and r is significant for operator 2, although not very high in value. There is the usual compression of ratings with the corresponding tendency to underrate good performances and overrate poor performances. The "difficulty" margin is thus much in evidence.

(*b*) *Tie Knot*.—(Figs. 15, 16, 17 and 18).

(1) All three distributions for observed times tend to be rectangular, indicating instability of conditions. Presumably all three operators are still finding this a difficult job, but 1 and 3 are much further advanced in self-training to overcome the difficulties than 2.

(2) From the distributions for rated times and ratings it would appear that the time-study man has considered that 1 and 3 are working fairly consistently at just below and at standard effort, whereas 2, in addition to having difficulty is not working quite so hard. As the average and mode for 2's rated times are higher than for 1 and 3, operator 2 is being treated rather more kindly.

(3) Regression shows the usual characteristics of a short range of ratings.

(*c*) *Straighten Cake*.—(Fig. 19).—Here the rectangular distribution shows that all three operators are in serious difficulty and have not yet discovered how to do the job to the best advantage. Rated times give the same average and mode for 1, 2 and 3, and as in "Tie Knot," operators 1 and 3 are considered to be working in the 70 to 80 range, whereas 2 is rated from 50 to 70.

Conclusion

The above article has for practical reasons been confined to certain special aspects of the use of statistics in connection with time-study. It has not, for instance, referred to the method of time-study devised by L. H. C. Tippett, originally called "Snap Reading" and now "Ratio Delay" or "Activity Sampling," a method founded on statistical reasoning, nor to the valuable help afforded by statistics in examining the problem of machine interference. The principal stress has been on the fact that the simplest of all statistical tools, the distribution curve, can be of immense assistance to the practical time-study man, providing him with much key information which he would be otherwise unable to obtain.

It would not be wise to draw too many hard and fast conclusions from the time-studies of manual operators, which are the basis of this part of this article, as they themselves form only a small sample of a population of time-studies. Nevertheless certain points emerge. The first is that benefits can be obtained by time-study men who use ratings if they will plot distributions of observed times, rated times, and ratings, and also draw a regression diagram and obtain a line either by the usual formulæ or by short-cut inspection methods. From the distribution curves they will be able to obtain a good indication of the uniformity or otherwise of the job which they would not be able to obtain from the tabulated results, and if they are making studies of more than one operator a ready means will be provided of assessing the relative mastery of the job of the different operators. The regression diagram will show the extent of the "variability" or "difficulty" factor and the degree of "steepness" of the actual line. The former will be a useful check on the general effectiveness of rating as an adjusting factor in the particular time-study under consideration, and the latter will show the extent to which the time-study men are compressing the range of ratings they are using. It is suggested that the best way to obtain the "80 (or other standard) rating time" is to use the value shown on the regression line rather than take the mean or mode from the distribution curve of rated times as is a current practice.

Pitsford Water Supply Scheme

On October 25th, H.M. Queen Elizabeth the Queen Mother inaugurated the Pitsford reservoir and its associated works. The reservoir is situated about 5 miles north of Northampton, on the Pitsford stream, a tributary of the Brampton branch of the River Nene. Northamptonshire is a county which has, traditionally, had difficulty in maintaining adequate water supplies, and the present scheme is expected to give a marked improvement. In 1949, an amalgamation of sixteen local authorities and two water companies was effected with the formation of the Mid-Northamptonshire Water Board. The Board is responsible for supplying about 300,000 people in an area of 500 square miles ; powers to construct the Pitsford reservoir were inherited by the Board, and its construction together with that of four area distribution schemes was put in hand as quickly as possible. All this work is now complete ; its cost is stated to be about £4,000,000.

The reservoir will yield about ·4 m.g.d. in dry times. Its storage capacity is 4000 m.g., and its top water level 295ft A.O.D. ; the gathering ground is about 19 square miles in extent with a long term average rainfall of 25·3in. Compensation water is discharged at a rate of 0·2 m.g.d. in winter and 0·6 m.g.d. in summer. Powers have been obtained to construct an intake in the Kislingbury branch of the River Nene, from which water will be pumped to the reservoir ; this addition is expected to double the yield of the scheme. It will involve constructing a pipeline 8 miles in length with a capacity of 20 m.g.d.

The reservoir is formed by an earthen bank, with a puddle-clay core. Soft alluvium at the dam site, totalling 63,000 cubic yards, was removed to depths up to 16ft, to give a formation on Blue Lias clay. The principal dimensions of the embankment are : length 1900ft ; maximum height, 56ft ; volume about 500,000 cubic yards. The draw-off tower has control of water at three levels, and leads to an 11ft 6in tunnel, used for the stream-diversion during construction. There is also a spill-weir 142ft long, and a concrete overflow channel. A subsidiary embankment cuts across the upper end of the reservoir carrying a road diversion.

Raw water flows from the tunnel to a pumping station just downstream from the dam, and thence is pumped to a treatment and filtration plant built close to the left-bank abutment of the dam. The plant consists of a chemical block, reaction tanks, filters, filtered water tanks and a pumping station. Its output is 10 m.g.d. Here a recent trend in waterworks practice is evident, for all the controls of the operations of this plant—pumping, chemical mixing, filter washing and so on—and also of the raw water pumping station are automatic, or semi-automatic. The treated and filtered water is finally introduced into the network of trunk mains, service reservoirs and distribution mains, supplying various parts of the Board's area. Extensive works have been in progress on the distribution system, as we noted above. Many miles of mains from 36in to 3in in diameter have been laid. A service reservoir of 5 m.g. capacity has been built at Hannington, and nine other service reservoirs and nine water towers have been built ; four principal repumping stations have also been built.

Pitsford reservoir has been built under the supervision of the consulting engineers T. and C. Hawksley ; the main contractor was Sir Alfred McAlpine and Son, Ltd. However, the treatment and filtration plant and pumping stations at the reservoir site have been the responsibility of the Mid-Northamptonshire Water Board's chief engineer, Mr. L. H. Brown, who also designed and supervised the area distribution schemes.

North of Scotland Hydro-Electric Schemes

No. VIII : THE GARRY AND MORISTON SCHEMES—PART VI*

(*Concluded from page 614, November 2nd*)

The adjoining catchments of the Garry and Moriston rivers in Inverness-shire have for many years been recognised as favourable sources for the development of hydro-electric power. The North of Scotland Hydro-Electric Board's developments here will yield about 383 million kWh annually, from an installed capacity of 106MW. Plant layout and design of the upper Moriston scheme are described, and the lower stage works, which are still at an early stage of construction, are briefly explained.

THE underground power station at Ceannacroc has two vertical-shaft Francis-turbine-driven machine sets installed in it, one a 16MW set for the principal generation of power, and the second a 4MW set which can be operated at times of low load to pass the statutory quantity of compensation water. The 16MW set is similar, as already noted, to the two sets to be installed in the lower-stage station at Glenmoriston. Because of this, and because the lower stage is still at a relatively early stage of construction, we have not included a detailed account of the plant design or of the construction of that section of the scheme ; however, some points of comparison with the upper stage are noted here and there in the ensuing description. As we go to press we learn that Ceannacroc power station has just been put into commission and both sets are delivering power to the grid. The maximum continuous ratings of the two sets in the power station are respectively 4·7MVA and 18·9MVA, each at 0·9 p.f.

The smaller Francis reaction turbine is capable of operating when the net head is 205ft to 295ft at a normal speed of 500 r.p.m. The maximum efficiency is obtained at an output of 4750 b.h.p. at a net head of 254ft. A 42in rotary valve with metal-to-metal seals controls the turbine inlet. The valve is of cast steel and the rotating member is not unlike a tapered plug. The valve servo-motor is hydraulic, utilising the pipeline pressure. The alternator is totally enclosed and water cooled, and has main and pilot exciters with a permanent magnet generator for driving the actuator mounted at the top of the unit. It has a combined thrust and guide bearing and a lower guide bearing. All bearings are self-pumping with water cooling from the spiral casing.

The principal turbine operates over a net head range of 205ft to 267ft at a normal speed of 375 r.p.m. The maximum efficiency is obtained at an output of 19,000 b.h.p. and a net head of 254ft. The straight-flow inlet valve has a diameter of 6ft 4in, and has external servo-motors, a pressure-operated rubber seal on a stainless steel seat, and an automatic by-pass valve for filling the spiral casing. An emergency seal enables maintenance to be carried out without draining the high-pressure pipeline.

The turbine runner is of stainless steel and the spiral casing, of welded steel plate, was completed in one piece in the works. As in the case of the other stations in the Garry–Moriston schemes, the turbine has been arranged so that operation of the alternator as a synchronous condenser can be achieved.

The alternator is a two-bearing machine with one combined thrust and guide bearing above the rotor hub and one guide bearing below the rotor. A further guide bearing is fitted to the turbine shaft on the turbine top cover. The alternator bearings have a lubricating oil system with external pumps and oil coolers. The guide bearing pads for the turbine have embedded water tubes with a supply from the pipeline. Governor oil and braking systems are similar to those described for the Invergarry machine.

There are two identical pumps for station drainage and dewatering, which operate singly for drainage, on an electrode system, and in parallel for dewatering.

At Glenmoriston power station the two generating sets are to be similar, with the exception that the turbines will be able to operate when the net head is in the range 270ft to 306ft. The maximum efficiency will be obtained at an output of 19,000 b.h.p. at a net head of 285ft. There are no relief valves on the turbines at Ceannacroc or Glenmoriston.

ELECTRICAL SYSTEM

The two alternators at Ceannacroc are connected by cables to a bank of 11kV switchgear installed in a switch building near the access tunnel portal. The 16MW machine is controlled by a new design of high-speed automatic voltage regulator incorporating magnetic amplifiers in its circuit. The 4MW machine is controlled by the more conventional astatic automatic voltage regulator and care has been taken in the overall circuit design to allow for parallel running and line drop compensation.

The 11kV switchgear is of single busbar construction, employing 11kV metalclad circuit breakers of 500MVA capacity. Control of the 11kV switchgear is in the turbine hall, which will be mainly attended.

Duo-bias differential protection is provided for the two machine circuits and also for the transformer circuits, with the usual form of instrumentation for the machines and transformer and, in addition, an automatic selection of voltages for synchronising. An earthing transformer is connected to the lower voltage terminals of the main transformer, giving a point for earthing the 11kV system neutral through an earthing resistor. The machine enclosures contain current transformers, placed at the neutral end of the machine terminals, and a neutral link which is normally left open. Because of their position underground, the unit transformers and voltage transformers have been manufactured with special insulation to avoid risks of fire.

A motor-operated 132kV isolator on the outgoing side of the transformer is controlled from the power station board. Each isolator is equipped with hand-operated earthing blades for earthing the O.H. line during maintenance. Interlocks ensure correct operation. Faults which might occur on the transformer are dealt with by the use of a 132kV fault-throwing switch which places an artificial fault on one phase of the 132kV system, for the automatic tripping of the corresponding 132kV circuit breaker at Fort Augustus. A similar switching arrangement, with protective schemes, will also be

* No. I : "An Introductory Survey," appeared July 14, 1950 ; No. II : "The Loch Sloy Project," July 21-August 4, 1950 ; No. III : "The Fannich Project," June 8-15, 1951 ; No. IV : "The Mullardoch-Fasnakyle-Affric Project," April 11-25, 1952 ; No. V : "Some Schemes for Local Supply," October 16-23, 1953 ; No. VI : "The Tunnel Garry Scheme," September 2-23, 1955 ; No. VII : "The Shira Scheme," April 20-27, 1956.

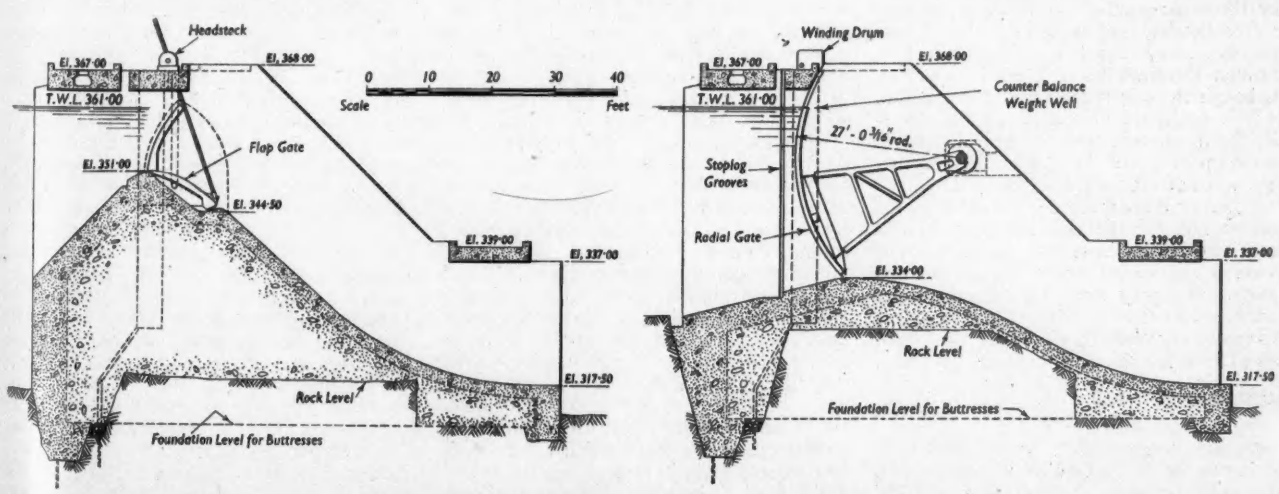


Fig. 15—Cross sections through Dundreggan dam. (Left) Centre opening of 20ft with flap gate. (Right) On each side of the centre opening there are to be piers 10ft wide flanked by openings of 28ft 6in, each controlled by a radial crest gate as shown

provided at Glenmoriston. The main power cables and auxiliary services from the machines at Ceannacroc are brought to the 11kV switchgear through concrete cable trenches on each side of the road through the access tunnel. All cables on this route are mass impregnated and non-draining and special care was taken in clamping them because of the 1 : 10 slope of the tunnel.

The gate at the surge shaft can be closed, in an emergency, from the turbine hall. A composite cable was thus laid overground between the switch building at the power station portal and the gate house some 400 yards distant. The cable comprises two main 110V d.c. cores, two 240V a.c. cores and five pairs of 40 lb per mile conductors twisted in pairs and screened overall for communications and control circuits.

The lighting of the underground station at Ceannacroc is somewhat novel and consists of continuous fluorescent trough fittings mounted behind the crane beams, allowing light to flood upwards and downwards, the effect being to over-emphasise the natural rock walls and also to light the concrete vaulted roof from which reflected light helps in the general illumination throughout the hall. The effect of this system is like day-light on a dull day, which is, we are informed, considered most pleasing.

It was decided to omit, during the initial installation, any special ventilation plant for the underground station. The tail-race is free flowing and is connected with the turbine hall by tunnels to allow air to flow through the station and the access tunnel. Although there is space for the installation of fans, so far there appears to be no necessity for them. It is considered a little early in the operation of this station to state that fans will not eventually be required.

A unit contactor board is provided in the turbine hall for the unit auxiliary services associated with the large machine. The board has a manual change-over switch and derives its supply from a unit transformer connected to the terminals of the machine. An emergency stand-by supply can also be obtained from the station common services board.

Subsidiary Power Stations at Loyne and Cluanie

Cluanie compensation water station is similar to the one at Quoich ; it employs a horizontal Francis turbine driving a 300kW induction generator running at 500–507 r.p.m. The flow is between 30-45 cusecs over a head range of 44ft to 114ft. At Dundreggan, the compensation set will have a vertical propeller turbine operating over a head range of 39·5ft to 46·5ft. Compensation water requirements are 49 cusecs (summer) and 18·5 cusecs (winter). The generator is a direct-drive induction machine developing 160kW at a speed of 1020 r.p.m.

The power station at Loyne, which utilises the water diverted from Loyne to Cluanie reservoir, is of similar design to the Mullardoch station of the Affric scheme. A 550kW induction generator situated at 707ft O.D. is driven, through an intermediate shaft, by a Kaplan turbine at 685ft O.D. The guide vanes are operated mechanically, and the runner blades by a hub oil servomotor. The design head is 30ft and the average flow is 100 cusecs.

These subsidiary stations are connected to the 33kV overhead line system connecting with the board's main 33kV system at the Beauly switching centre. A medium voltage air circuit breaker controls each generator and the output is then stepped up by a transformer direct to the 33kV system. Auxiliary services for the small power stations and head-works are derived from the medium voltage switchboard which contains the air circuit breaker. The Loyne and Cluanie stations will be connected with the Ceannacroc station by a pilot cable over which telephony can take place and an alarm can be given.

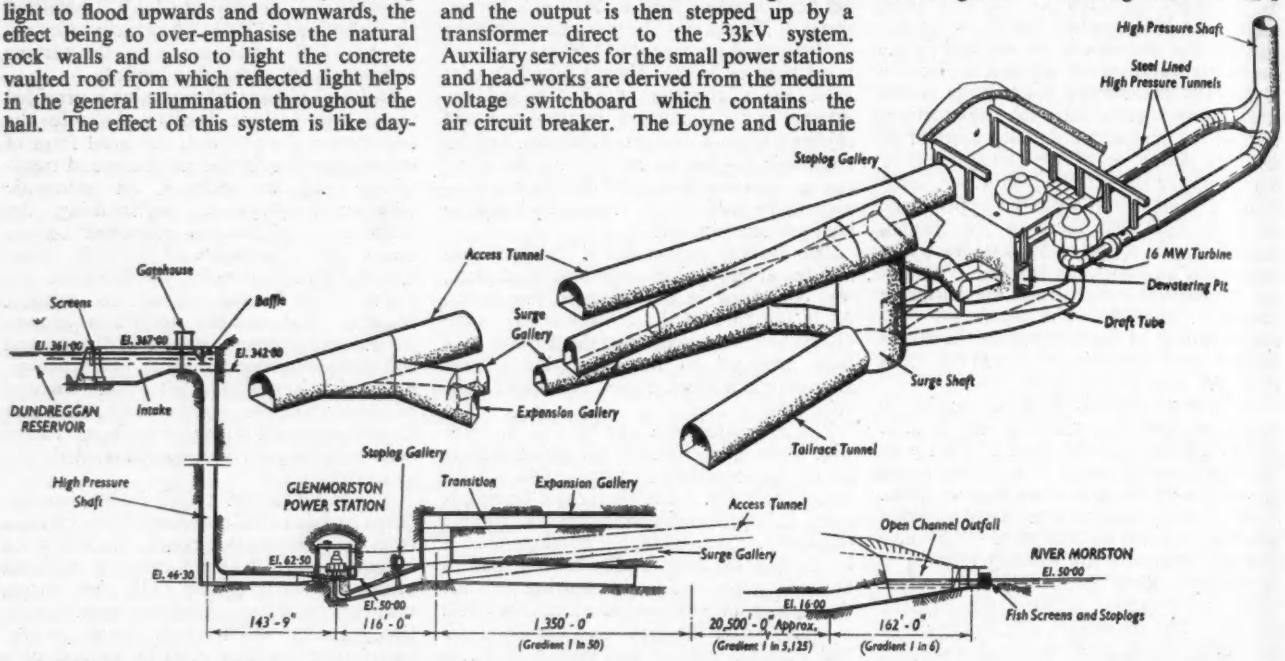


Fig. 16—Glenmoriston power station and its associated tunnels. A cross section of the lower Moriston stage is shown in the lower view. The isometric diagram illustrates the functions of the various tunnels

The Lower Stage of the Moriston Scheme

In the opening section of this article we pointed out that the principal advantage in building underground power stations at the Moriston scheme lay with the lower works, which have been greatly simplified. The original intention was to build a dam with a power station nearby at Dundreggan (at approximately the site of the present dam) with an installed capacity of 13MW, followed by a second reservoir, just below the power station, formed by a dam 95ft high about 2 miles upstream from Invermoriston. Then a tunnel and pipeline would have led to a 20MW power station situated at about the same spot as the end of the present tail-race tunnel. The proposed power station serving the Livishie catchment, on the left bank, was originally intended to discharge into the lower reservoir. Thus the modifications have decreased the head which will be available for the Livishie turbine, but the overall utilisation of its flow has been slightly increased.

We illustrate in Figs. 15 and 16 the dam and power station of the lower stage of the scheme. The dam is not dissimilar to the Invergarry dam in many respects. It has to cater for sharp floods, and to accommodate a fish pass, compensation water turbine, and an intake, with coarse and fine screens, leading to the shaft of the power station.

Radial crest gates are to be used on this dam for the first time in the Board's works. There are two such gates, as illustrated in Fig. 15, with a flap gate in the centre opening. The latter gate is intended for passing surface debris, and for controlling minor fluctuations in the reservoir level. It is hinged at the base and controlled by turning the screwed rods at either side, as shown in the drawing. All gates are automatically controlled.

Hydraulic model tests were carried out at the site to check the flow conditions at the top of the shaft. Modifications made as the result of the model test, eliminated vortex formation by introducing an inclined baffle which is indicated on Fig. 16. The control gate is also being tried out on a hydraulic model, to study its behaviour at partial openings, and this work, too, is being done at the site office.

The Glenmoriston station (Fig. 16) follows a similar design to that at Ceannacroc, except that, with the station so close to the dam, there is a difficult problem with the surge in the tail-race. This has been solved by building the expansion chamber and two tunnels shown in the drawing. This arrangement has been evolved from model tests (carried out at the Heriot Watt College at Edinburgh) starting with the simplest layout which met the practical requirements of construction. The "surge gallery" sloping down to the tail-race tunnel was needed for access during construction. The simplest addition to cater for surge was therefore the vertical shaft or chamber. These two tunnels, however, were unsatisfactory hydraulically, in that there was resonance between them, so the tunnel connecting them at the level of the top of the surge chamber was added, and the slopes modified, to give the desired results.

At the present stage of construction, little further description can yet be given of the lower Moriston works. The driving of the long tail-race tunnel is, however, well under way, and some novel plant is in use. One adit is being used. Spoil is to be carried from

the adit to the tips on a belt conveyor, in which two steel cables, with the belt resting on them, are hauled along, over light roller supports spaced much farther apart than conventional conveyor supports.

Railed vehicles have been dispensed with at the tunnel face. The jumbo has pneumatic tyres, hinged side platforms, and air and water leads to the various drilling positions built in. Thus it simply has to be wheeled to the faces and connected to the air and water mains to start a drilling cycle. The usual "pull" is 7ft or 8ft. An Eimco loader with crawler tracks mucks out the spoil loading into tipping trucks. The trucks consist of "Fordson" tractor chassis, each with a tipping body and with a gravity-operated door, carried on a pivot on the chassis and on a pair of wheels. The trucks tip into the conveyor at a terminal pit in the tunnel, arranged with a pivoted balanced track across it. Thus a vehicle travels over the pit, its weight depressing the track, which rises again as the vehicle runs clear, thus allowing the load to be tipped. The vehicle can then by-pass the pit and return to the face without turning. Another example of rather novel plant in this tunnel is the air main, which is a plastic hose, reinforced with steel rings.†

The lower Moriston works, namely, the Dundreggan dam, the underground power station below it with its appurtenant tunnelling works, and the long tail-race, to Loch Ness, are all being constructed by Duncan Logan (Contractors), Ltd. All these works are under the supervision of the consulting civil engineers, Sir William Halcrow and Partners. The electrical and mechanical work for the upper stage of the Moriston scheme has been carried out by a number of contracting firms, all responsible to the electrical and mechanical consultants, Messrs Kennedy and Donkin; they are as follows:—

16MW generating set, English Electric Company, Ltd.; 4MW generating set, Harland Engineering Company; 11kV switchgear, A. Reyrolle and Co., Ltd.; power and auxiliary cables, Pirelli-General Cable Works, Ltd.; medium-voltage switchgear, Artic Fuse and Electrical Manufacturing Company, Ltd.; lighting and heating and cables for subsidiary stations, William Allan Smith and Co.; transformers, Bruce Peebles and Co., Ltd.; 132kV motor-operated isolators and fault throwing switches, Switchgear and Equipment, Ltd.; power station crane, Marshall, Fleming and Co.; station batteries and chargers, Pritchett and Gold and E.P.S. Company, Ltd.; lighting fittings for turbine hall, Hume Atkins and Co., Ltd.; 300kW induction set at Cluanie, Armfield Hydraulic Eng. Company, Ltd.; 500kW induction set at Loyne, Boving and Co., Ltd.; medium-voltage switchgear for compensation stations, English Electric Company, Ltd.; lifting appliances, Cluanie and Loyne, Felco Hoists, Ltd.; main transformer for Loyne, Bonar, Long and Co., Ltd.

Institution of Civil Engineers

PRESIDENTIAL ADDRESS

The Institution of Civil Engineers' president for the session 1956–57 is Mr. H. J. F. Gourley. Last Tuesday, Mr. Gourley delivered his address, and abstracts from it are printed here. In the sections which we have chosen for reproduction, Mr. Gourley draws attention to the decreasing proportion of full members in the Institution's roll, and comments on how this reflects on the profession's influence and prestige. He then surveys some of the recent technical developments in constructing dams and reservoirs.

IN 1910 the total membership of the Institution was 8794; of these, 2303 were members and 4709 associate members. By 1935 there were 10,835 on the roll, of which 2222 were members and 6937 associate members. In 1955 the figures were 20,656, 2456 and 11,123 respectively. Whilst the increase in total membership is evidence of the gathering strength of the Institution, the fact that the number of members has remained substantially static over forty-five years, whilst the number of associate members has nearly trebled certainly calls for comment. The gap between the number of associate members and members is widening. The pre-1939 increase of associate members was 175 per annum and the post-war rate is 500 per annum. Can anything be done to restore a more reasonable balance between the two classes?

I think all who have the interests and the prestige of the Institution at heart should consider it a duty to achieve the higher status which full membership confers. As a young man my aim, and I believe that of many of my contemporaries, was to gain such experience and responsibility as to fit me for attaining full membership as soon as possible: in those early years it was not the salary a post carried which was a particular inducement as much as the opportunity to broaden one's experience. One of the alternative conditions of engagement for civil engineers in local government, colonial engineering, in the Civil Service, and in the nationalised industries, is that applicants for appointment shall be corporate members, and since this is satisfied by associate membership, it is possible, if not probable, that some take the view that there is no need to seek transfer.

Is there any explanation for the apparent failure to achieve that standard of experience and responsibility prescribed by the by-laws as a qualification for transfer, when such a course would indicate an engineer's degree of competence amongst those best qualified to judge? It appears to me that employment in the undertakings to which I have referred must inevitably reduce the opportunity to reach positions of responsibility at a reasonably early age and that many young engineers are engaged on tasks in such undertakings which are below their technical capacity: also that there must be a tendency to canalise their duties, with the result that the field covered by their activities is narrowed and not broadened.

The shortage of engineers has been the subject of public discussions, and arrangements are in hand to increase the yearly turnout of technologists by 50 per cent. This increase will not overcome the shortage, but it is a start towards solving a problem which is of far-reaching importance to the future of Britain.

I fear the engineering graduate of to-day is much too inclined to take as his first appointment that which carries the highest salary—more often than not offered by a nationalised industry or a similar large undertaking—and such an approach to a professional career is, I consider, one of the factors which accounts for the declining prestige of the civil engineer. The most important aim of the young engineer should be to obtain good experience in design and on works, and subsequently to broaden his experience in both fields. With such a foundation his future can be assured. His status achieved, positions of increasing responsibility can be filled with pleasure and satisfaction. To assess the status of any professional man merely in terms of money is a mistake: the real measure of his worth is the service he renders to the community, which is not measured by any monetary standard. If in addition to technical competence he brings to his work breadth of vision, integrity and independence, then the engineer will receive the respect to which he is entitled.

When our Institution was founded in 1818 its members were mainly self-employed, as were doctors and lawyers. They had a tradition of personal service and professional pride which was irrespective of fee or reward. Consequently their services to the community were recognised, and the profession achieved a status which it maintained till at least the turn of the century. To-day the number of self-employed or consulting engineers is relatively small, although the number of corporate members engaged by them or working under their direction is more substantial. The greater proportion of our membership is engaged with the larger organisations I have mentioned. I feel that in those organisations there cannot be such opportunities for the exercise of initiative and independence as there are in other spheres and that without those opportunities in may be difficult to qualify for transfer.

The Status of the Civil Engineer

By the breadth of his experience, his ability to manage men and machines, and his practical and realistic approach to the problems of design, construction and organisation, the civil engineer would appear to be pre-eminently fitted to hold managerial appointments. It is therefore somewhat surprising that so often such executive positions are filled by men of other professions, or even by those with no professional background at all. It seems unfair that, although the civil engineer has made—and continues to make—very substantial and far-reaching contributions to the welfare of the community, his efforts are rarely brought to the notice of the general public. The leaders in the profession are well known amongst our members, but are only too seldom recognised outside the Institution. How different in other professions where the outstanding leaders are given recognition and their names become household words. It is true that civil engineering is so interesting in all its aspects—human and material—that those so engaged get such immense satisfaction in the conception of schemes and in their execution that they become indifferent to recognition. It is also true that our journal constitutes a record of technical achievement over the years of research and of development in the technique of design and construction. These records are very seldom consulted by the outside world, and unless we do something to bring before that world information about our activities we really cannot complain about the lack of recognition and appreciation of our efforts.

The finest tribute ever paid by a statesman to our profession must surely be that by Lord Cromer. I quote from his *Modern Egypt*:—

"The British Engineer, in fact, unconsciously accomplished a feat which, in the eyes of a politician, is perhaps even more remarkable than that of controlling the refractory waters of the Nile. He justified Western methods to Eastern minds. He inculcated, in a manner which arrested and captivated even the blurred intellect and

† See THE ENGINEER, page 175, February 4, 1955.

wayward imagination of the poor, ignorant Egyptian fellah, the lesson that the usurer and the retailer of adulterated drinks are not the sole products of European civilisation: and, inasmuch as he achieved this object, he deserves the gratitude not only of all intelligent Asiatics, but also of all Europeans—of the rulers of Algiers and of Tunis as well as those of India."

Lord Cromer's book was published in 1908, and the political scene meantime has changed considerably; but the development of the water resources of the countries of the Middle East proceeds with the aid of engineers and contractors from Britain and other western countries. There are also schemes in India designed by and being carried out under the direction of engineers of the Republic, a number of whom had the advantage of working with the former Public Works Department, many of whose senior officers were British engineers of considerable eminence and whose traditions have been inherited by the present régime.

In all this we should not be so modest as to forget or ignore the invaluable pioneer work of the British engineer to whom Lord Cromer referred, whose work not only showed the world what the engineer could do to raise the standard of living, but it also served to put before the nationals of under-developed countries a tangible exposition of the results of his labours.

Prospects for Civil Engineers

What are the prospects for civil engineers? Since 1945 there has been an increasing number of oversea projects, particularly in the Middle East, where the revenues resulting from the exploitation of oilfields by Western organisations have provided substantial funds for financing extensive public works, such as water supply for irrigation, for power, and for public purposes with, in many cases, the mitigation and control of floods; in sanitation; and in providing the means for transport—roads, railways, bridges, harbours and airports. All such developments will raise the standard of living, and as the people of the countries being developed learn to appreciate and make full use of the various facilities, so will they become more contented, healthier and wealthier.

To provide sufficient civil engineers to man these many and important development projects presents a difficulty which is not to be quickly overcome, and the insatiable demands for more technologists in the home market does not make the task any easier. I know from experience that not all who may be technically qualified are necessarily suitable in other respects for service overseas, but I also know that young men who gain experience abroad develop a sense of responsibility and initiative which will be assets in their subsequent career. By their social behaviour, ability, and integrity, they can enhance the reputation and prestige of British engineering. Under-developed countries do not necessarily want our political way of life, but they do admire our technical skill and our ability to get things done.

To design and construct the major developments overseas to which I have referred does, however, demand a high degree of technical skill, knowledge and experience. In many of the countries men with such qualifications are not available, though a number of their young men are obtaining technical education in Britain and elsewhere. There is an understandable desire on the part of their governments, and of the men themselves, that nationals should play an increasing part in the works of development.

At the beginning of the "oil era" the design and construction of the development projects had perforce to be entrusted to foreign engineers and contractors, and in this British firms participated. Dependent upon the resources, the industrial potential and the character of its inhabitants so the need for assistance is bound to lessen as a country gains in technical self-sufficiency. This self-sufficiency may be achieved slowly or relatively quickly, but, within the limits imposed by national and economic conditions, it must be the goal towards which the under-developed countries are striving. It is for consideration how technically equipped but inexperienced nationals may gain experience and professional competence.

New Techniques Concerning Dams

It is probable that as the world's resources in water power become fully utilised, atomic energy will become an important, if not the principal, source of power, but it cannot provide water for public use or for irrigation. So long as civilisation as we know it continues the search for water, then the construction of works for its conservation and utilisation will be the preoccupation of civil engineers.

The conservation of water connotes storage and this in turn necessitates dams, the design and construction of which I have been concerned with for many years. I do not propose to deal this evening with all that concerns dams. I will mention briefly some of the new or improved techniques evolved during my professional career, which have contributed to the speeding up of location, made possible the utilisation of otherwise dubious sites and materials, and accelerated construction.

One of the most useful tools now available to the civil engineer is the aerial survey. In developed countries survey maps are available which meet most requirements, but revision of these by topographic surveys is made at such intervals of time that in any specific case where urban and similar development is occurring the available maps are far from accurate. An aerial survey can be made quickly and the maps can be produced therefrom to any desired scale. In Britain aerial surveys are superseding instrumental surveys for the production of the contour plans from which the storage potential of a reservoir basin can be calculated. The time taken to produce such plans is but a small fraction of that required by instrumental methods and the total cost of the two methods is not widely different. Provided that control points are carefully chosen and accurately levelled the aerial survey contours are probably more correct than those obtained otherwise.

In under-developed oversea countries aerial surveying is most valuable. Until this technique was evolved maps were available only for limited areas and sometimes their accuracy left much to be desired. Although the scale and contour interval may not be altogether sufficient for a specific scheme, the maps give a reasonably accurate picture such as will enable the broad merits of alternative proposals to be appraised. More detailed and accurate maps can then be produced by the same means for the most suitable scheme. If the scheme under consideration is an irrigation project, by suitable ground sampling and analyses in conjunction with the aerial photography, maps can be made which will show not only the contours but also the soil classification: these maps can be produced in a relatively short time and thus speed up the formulation of the project.

Much useful information about a potential dam site is obtainable by geophysical methods. Whilst in most cases it would be imprudent to rely only on the geophysicist, the great merit of such an investigation is that it gives a picture of the underground conditions quickly and cheaply and enables the necessary confirmatory boreholes and trial shafts to be located in the most advantageous positions.

If the reservoir is to be created by an embankment, the physical characteristics and quantity of the various materials available for the dam within economic reach of the site must be investigated; here again the geophysicist is involved. Samples for soil mechanics laboratory analysis will be required from boreholes and test pits to confirm and supplement the geophysical survey.

If the most economical design with the necessary factor of safety against failure of the foundation or the superstructure is to be evolved, assurance can be obtained only by a thorough site investigation. Cost may range from 1–5 per cent of the total for construction—a small premium for insurance against failure or the possibility of having to make radical changes in design after construction has commenced with its resultant delays, difficulties, and extra costs.

When reservoir embankments were first made in this country 150–160 years ago, the banking was transported by dobbin carts. It was spread in thin layers, and consolidated by sheep driven over the embankment; so that the general rate of raising was consequently very slow. Fifty years ago material was transported by side-tipping wagons drawn by locomotives. It was spread in 18in layers and, starting at the outer edge of the embankment, the railway track was slewed inwards towards the puddle wall. Finally, the new layer was consolidated by a heavy roller or punned by manual labour. Although the bank was raised more rapidly than 100 years earlier the rate was still far slower than it is to-day.

In the modern embankment where 10–20 cubic yard dumper loads are brought to the bank, tipped, spread by bulldozer, and compacted by various mechanical means, the rate of raising may be about 3ft a month in the lower part of the bank to 5ft or more in the upper part. Whether such rates will overload the foundation of the bank or give rise to excessive pore pressure and instability in the embankment depends upon the characteristics of banking material. The possibility of the building-up of dangerous pore pressure can be obviated by the provision of special relief drainage. The acceleration of construction by modern methods may well account for the troubles which have arisen in some recent embankments and also may possibly have precipitated foundation failures. Despite the speed of construction of the modern reservoir embankments and their height—some are 300ft or more—they can be designed with the requisite factor of safety by the application of the principles of soil mechanics. The cross section of these dams has in some cases moved far from the simplicity of the typical embankment of the 1900s—some are by comparison quite complicated.

Notable advances have also been made in the treatment by grouting of water-logged alluvium at the site of embankments. To attempt to sink the cut-off trench to the underlying rock would involve heavy and prolonged pumping, costly excavation, and possibly impair the strength of the foundation of the embankment. By the use of grout, pumping and its attendant cost and disadvantages may be avoided; the medium employed is determined by the particle size

of the material to be grouted. For gravel a cement-sand mixture would be appropriate and, as the material became finer, cement only would be used. If silt were encountered chemicals might be necessary. The area to be treated in this way may be confined to the cut-off or in some cases be more extensive.

Cementation for problems of this kind has of recent years been used, particularly in France. In England an interesting application has been to solidify water-bearing beds, which will be encountered in the long inclined approaches to the Dartford vehicular tunnel now in course of construction. It may be that cementation will prove to be the most suitable and economic treatment for the cut-off of a proposed earthen embankment in Hong Kong, where it may be practicable to form two parallel lines of grout curtain so that the intervening material may be excavated in the dry to such depth only as will ensure freedom from settlement of the concrete core wall if that should be incorporated in the embankment. Before the technique of pressure grouting was developed, it was customary to carry the cut-off trench of embankments and concrete dams sometimes to great depths in shales and stratified rocks so as to intercept and seal all open joints and fissures. Nowadays, the trench is limited to the sealing of the larger joints and fissures by concrete, and by pressure testing and cement grouting of boreholes below the bottom of the trench the necessary watertightness is achieved, generally with smaller outlays of time and money.

There are dam sites at which distinctly adverse geological conditions are to be found; for instance, limestones where extensive joints and fissures, with possibly solution channels, are encountered. In such cases the foundations may be rendered watertight by extensive grouting; cementation on this scale is costly, but in the circumstances it is usually the only means by which otherwise potentially valuable sites can be developed. In Italy, where very high concrete arch dams for power development have been constructed in gorges in the dolomitic limestone, watertightness and stability of the base and flanks has been obtained by cementation. And at the site of the Dokan dam, where dolomitic limestones are encountered, a considerable programme of grouting, both for filling fissures and for increasing watertightness by a "curtain," is in hand.

Before the extent of the grouting operation can be determined in such cases as have just been quoted an intensive exploration by borings and water-pressure testing is essential. It is important, in my view, that the services of a geologist should be available for the interpretation of the results and to advise on such further investigations as may be required to ensure that an adequate and detailed picture of the underground structure and other germane factors is obtained. In Britain visits by the geologist at appropriate times can be easily arranged, but for oversea projects it is necessary for him to live on the site, at least during initial periods of the investigations.

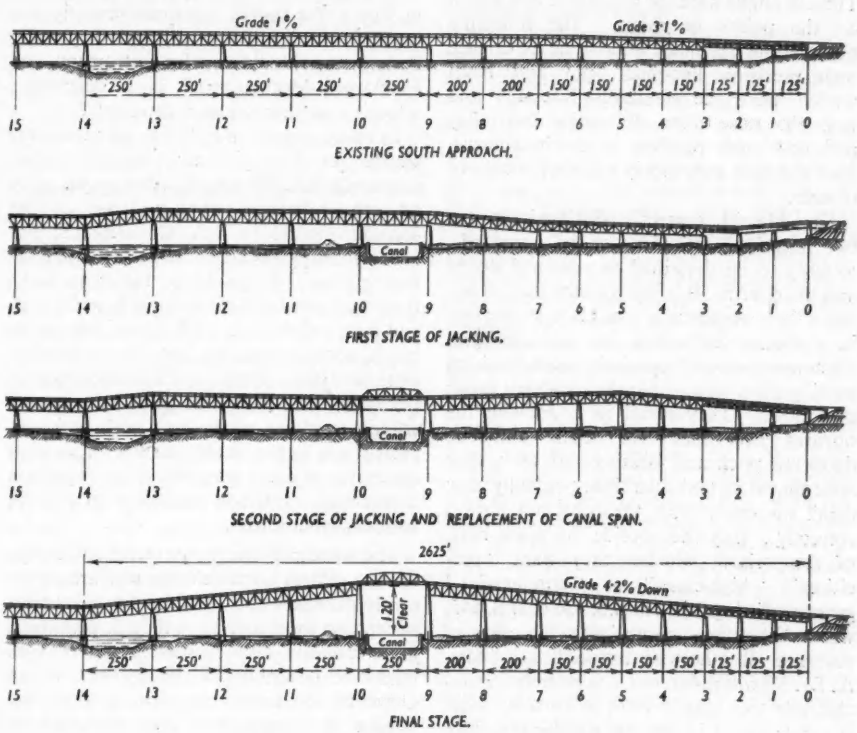
I have so far dealt in the main with earthen embankments for it is in that field that many developments in design and methods of construction have taken place. This, however, is not to say that developments connected with other types of structure have not occurred, for indeed they have, though in general over the past twenty years these have been logical developments and improvements in techniques and design rather than radical changes. Much more could have been said and still more on the progress elsewhere in the same field but there are limits to your forbearance; suffice it to say that as in every sphere of civil engineering the art and practice of our profession is not, nor never can be static; time marches on and so do we.

Proposed Raising of a Canadian Bridge

As part of the readjustment of communications called for in the construction of the St. Lawrence seaway, it is proposed to raise the southern end of the Jacques Cartier bridge and replace one of its spans. We are informed by the Dominion Bridge Company, Ltd., which is the contractor responsible to the St. Lawrence Seaway Authority for the raising operation, that the contract is believed to be the largest of its kind yet undertaken; its value is nearly 7,000,000 dollars.

The Jacques Cartier bridge crosses the St. Lawrence River from Montreal to its south shore. It was built in 1929, to the design of Dr. Pratley, by the Dominion Bridge Company; Dr. Pratley is again consultant for the present work. The Seaway canal demands a vertical clearance of 120ft above high water level, an increase of about 80ft over the present figure; the roadway itself will have to be raised by about 50ft. The accompanying diagrams illustrate how this will be achieved. Span 10, a "deck" truss 35ft deep and bridging 248ft, will be replaced by a "through" truss, and this span and thirteen others will be raised by varying amounts. During all this work the bridge will be kept open to traffic continuously.

A simplified sequence of events is shown in the four diagrams, as follows. First, the original southern section of the bridge between St. Helen's Island and the south shore of the St. Lawrence River opposite the city of Montreal. At this stage temporary Bailey bridges with connecting turnout platforms and temporary access roads are to be erected to give alternative access over the length of spans 0 to 2; also the main bridge piers will be enlarged to accommodate the extra height. Second, the existing southern abutment, and spans 1 and 2, are to be raised, a new abutment constructed, and an additional 65ft plate girder span placed in position; also a number of spans at the northern end will be jacked to varying levels. Span 14 will be moved to its final position and span 10 will be jacked to a level position, ready for the installation of the new through truss. During the course of this work traffic will be diverted over the Bailey bridges, but these temporary crossings will later be removed, and traffic allowed to proceed over the new plate girder span. Third, the new through truss span will be erected on the upstream side, using timber falsework from the canal bottom, and slid into position as the old deck truss span is removed on the downstream side. A number of spans at the southern end of the project will be jacked by various amounts during this stage, thus achieving the final levels up to pier 5. Fourth, this stage will comprise the final jacking and heightening of the piers. Throughout the many lifting stages the various spans will be raised 6in at a time and the bridge supported on concrete blocks. At intervals of 2ft concrete courses will be poured on the piers. This process will be repeated until the final levels are reached.


Grade 1%
Grade 3·1%
250' 250' 250' 250' 250' 200' 200' 150' 150' 150' 150' 125' 125' 125'
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
EXISTING SOUTH APPROACH.
Canal
FIRST STAGE OF JACKING.
SECOND STAGE OF JACKING AND REPLACEMENT OF CANAL SPAN.
2625'
Grade 4·2% Down
120' Clear
FINAL STAGE.

Stages in raising the Jacques Cartier bridge

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

TURNBARRELS, TENSION RODS AND SWAGED CABLE-END CONNECTIONS (UNF THREADS) FOR AIRCRAFT

No. 2SP.101–104 : 1953. Price 5s. In the revised editions of these standards, items with No. 8–32 UNC and No. 10–32 UNF threads have been provided for to complete the range of aircraft cable-end connections with Unified threads.

The standards provide a tensioning device for aircraft control cables, and a variable range of cable-end fittings, as a safeguard against the crossing of controls.

PAPER-COVERED RECTANGULAR COPPER CONDUCTORS FOR TRANSFORMER WINDINGS

No. 2776 : 1956. Price 5s. This new British Standard for paper-covered rectangular conductors extends the range of the series dealing with covered conductors and specifies material suitable for winding medium-sized power transformers. The requirements for the conductor are based on B.S. 1432 "Copper for Electrical Purposes. Sheet and Strip," and those for the paper on B.S. 698, "Papers for Electrical Purposes." Methods of test are given, including an electric strength test on the finished conductor. It has not been possible to standardise sizes of paper-covered strip but a table of preferred sizes suitable for transformers up to 2000kVA is given.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

GEAR STANDARDS

SIR,—It was a pleasure to see Dr. Merritt's article "Whither British Standards for Gears?" in your issue of October 19th. There is ample need for discussion and action on the points he raises. The following observations are made after some experience with precision fine-pitch spur and bevel work. Here the standards B.S. 436 and B.S. 545 raise more difficulties than they remove; their relation to the instrument-gear standard B.S. 978 is a further source of trouble.

Dr. Merritt correctly distinguishes the two principal attitudes to the standards, roughly to be described as reasoned doubt and blind faith. It is unfortunate that all too often the manufacturer and his customer are in opposite categories in this division. Customers without specialist knowledge of gearing often seek to use the standards much as follows. They detail in a drawing the obvious necessities like tooth numbers, diametral pitch and locating surfaces; they state materials and quantities; usually they detail the crest, often the root, not always correctly: they then decide, on some basis of comparison, whether they want "precision," "high-class" or "commercial" gears, as distinguished in B.S. 436 or B.S. 545, which they then quote with the aim of covering all otherwise unspecified matters. As Dr. Merritt points out, it is entirely reasonable that they should want to do this; what is unreasonable is that the standards do not indicate (or attempt to obviate) the difficulties which remain. These are twofold: some questions are not covered at all, and others are arbitrarily blocked against desirable variations. The manufacturer can tacitly decide questions of the first type himself, and ordinarily does so. When he wishes for good reason to depart from the standard in minor respects, to achieve either better performance or economy of manufacture, having regard to available cutting equipment, he has first to spend time and trouble on the uncongenial task of undermining the status of the standard—a more difficult matter in view of the admitted authority and convenience of standards in other fields. This is the honest way: and the customer's first (and sometimes last) impression is that something is being put across him. He expects and considers that the standards are correct, complete and exclusive: they are not, and probably not intended to be, but they do not make this sufficiently clear. In other cases variations can be made without informing him, with little danger that he will notice, or complain if he does.

At a very low level, the standards have a use for dealing with those (and they exist!) who specify addenda of 1·0/D.P. in all circumstances, to the point of undercut and beyond; similarly they can help to convince others that good gears can be made with fewer than twenty teeth, and that whole depths are not 2·157/D.P., nor pressure angles 14½ deg., in current British practice. What whole depths are now supposed to be is not so clear, at fine pitches. They are evidently 2·25/D.P. for bevels, but for spurs they are 2·25/D.P. by B.S. 436 and 2·40/D.P. by B.S. 978. Although B.S. 978 exists and is applicable for pitches 20 D.P. and finer (explicitly in Part 3, for bevels, and implicitly in Part 1, for spurs), most customers ignore it even when it is fine-pitch gears they want. Perhaps the title "Gears for Instruments and Clockwork Mechanisms" is a deterrent: when is a mechanism an instrument?

In many respects B.S. 978 is the preferable choice for fine pitches; but the other standards, B.S. 436 and B.S. 545, as yet make no cross-references to it. Some of the accuracy figures in B.S. 436 and B.S. 545 become inappropriately large or small at finer pitches. It would be better to make these two standards cease to apply at 20 D.P. and finer; their finer pitch figures seem to be based, not on experience, but on unwarranted extrapolations. Even so, all these standards (including B.S. 978) class gears by accuracy criteria involving single-flank tests which at present are impracticable, at fine pitches, in the customer's and manufacturer's inspection departments, and not much less so even in national laboratories.

The standards cannot properly be blamed for the difficulties which can still arise over centre distances and backlash for gears with addendum modification; though perhaps a more extensive discussion of the alternatives might be desirable, in the manner of the German standards, recognising that the subject is complicated and that careful exposition is necessary if the standard is by itself to suffice to give full guidance to the non-specialist. B.S. 436 gives an indication of a maximum allowable tip relief, which cannot be applied in full at low tooth numbers without loss of continuous involute action, though this is not made clear. B.S. 978 is free from this difficulty. This is probably the most important matter which B.S. 436 leaves aside. Many customers quote B.S. 436 without even realising that there is an undecided question here; the good manufacturer has to use his judgment in regard to their implicit needs, outside of their explicit requirements.

A very comprehensive Admiralty memorandum on precision gearing (covering spur, helical and crossed helical gears) has been prepared and now exists in an advanced draft form. Presumably it has been prepared to meet service conditions not covered by the existing standards. It permits a tooth form according to either B.S. 436 or B.S. 978, or any intermediate case, with cautions regarding tip relief. Design and inspection procedures are covered in considerable detail, and gears are classified for accuracy according to properties which can actually be measured and inspected in quantity production (principally from continuously-recorded double-flank tests). Accuracies are sometimes lower, but more usually higher, than comparable B.S. figures, and are more realistic since based on production experience in the actual field concerned. Gears are at present being produced for Admiralty purposes in terms of these requirements; knowledgeable customers are beginning to specify other work in terms of the provisions and accuracy classes of the memorandum; and manufacturers in this field find this a convenient procedure. It has recently been suggested that this memorandum could well be made a basis for a new standard (or several distinct standards) for fine pitches. The present writer is here advocating recommendations originally worked out by others; to state this may add force to the argument. It is understood that the Admiralty authorities hope to treat bevel gears similarly, later; but this may well take some time.

Meanwhile, it seems desirable to emphasise that for spiral bevel and similar gears, the tooth forms are intimately connected with the design of cutters and generating machines, as Dr. Merritt remarked: even more so at fine pitches, when both faces of a gap are best cut together, with a root-cone apex quite distinct from the pitch-cone apex and a whole depth held between proper limits rather than uniquely prescribed. There is no reference to these matters in B.S. 545, and only a passing reference in B.S. 978, not sufficient to stop customers from designing (and sometimes manufacturing) inappropriate blanks. There are also considerations akin to the tip-relief question for spur gears (degree of localisation of the bearing on the length and on the profile) which it is well to realise the standards make no pretence even to touch. Finally, the standards of the machine manufacturer are indeed adequate here, as Dr. Merritt observes; and the calculations of machine settings are sufficiently laborious that it is a wanton improvidence to make any arbitrary insistence on negligibly different tooth proportions, at the price of complicated amendments to computing forms and literature which are readily available: particularly when gears are wanted in the small quantities often required for prototype instruments, in this field of work.

Customers for fine-pitch gears have, however, been known to insist on straight bevels rather than spiral bevels, solely because only the straight bevels were offered rigidly to B.S. 545; this consideration replaced any objective assessment of the relative performance. Neither the customer nor the manufacturer benefits from this.

THOS. H. O'BEIRNE

Glasgow,
November 3rd.

SIR,—Prior to Lewis's investigation, and to the well-remembered "Rock-and-Roll" controversy to which reference has been made, it is on record that there were forty-eight well-established rules for the working strength of gearing which differed from each other in extreme cases by 500 per cent! Thanks to the splendid work of engineers in this country and elsewhere during the last thirty-five years or so, acceptable methods of determining the basic rating of gearing have

been evolved, and from these it is a relatively simple matter for the gear user to make such numerical adjustments as may be necessary to suit the conditions of the drive. In common with many others, I am grateful to the British Standards Institution and to the standardising bodies abroad for sponsoring the work, as well as to the engineers of many nationalities who devoted their time to its execution and to the firms who defrayed the cost. To my knowledge the work is still in progress and some of the forecasts are encouraging. The B.S. Crane Committees, on which is is my privilege to serve, have made it mandatory that all gearing has to comply with the appropriate British Standard, and in recent specifications guidance is given regarding the application of the strength and wear formulæ. Without breach of confidence it can be stated that, as and when the crane specifications are revised, it is intended to continue the practice because it is regarded as unreasonable to expect others unfamiliar with crane problems to furnish data applicable to all types of crane and to the widely-varying operating conditions. If the three standards to which you refer in your leading article of October 19th, were expunged from the records and all efforts to revise them were abandoned, not only would it be to our detriment, but it would also be futile to attempt to draft any B.S. specification in which gearing is a vital component.

As recently as 1952 Dr. Merritt stated that: "Present methods . . . evolved over many years, on average, give reasonably satisfactory results and it is unlikely that any responsible gear designer would accept with confidence a drastic departure . . . from present methods." If this represents the position, any differences of opinion can be resolved, without rancour, if approached in a spirit of friendliness and goodwill, and it is in such a spirit that this letter is written.

H. H. BROUGHTON

Cheam, Surrey, November 2nd.

NEVER BE SHORT OF LABOUR

SIR,—In your issue of October 19th Mr. W. F. Wright forecasts that in the future we shall become so dependent on mechanisation that "man will idle." While I do not agree with this prospect at all, there is no doubt that the day will come when the stupidity of trying to make "full employment" will be obvious to all. Suppose automation were to become absolute. We should produce all the goods and services we wanted without any labour. We should, therefore, have no wages to pay and no costs would be incurred in production. We should have no income but as all goods would be costless, they would be given away. This would not suit us at all, as we should have no freedom of choice and we do not all want the same things, but there would be no problem of distribution.

The difficulty is in persuading people now that there is a part of the cost of consumer goods which is not distributed in incomes. This deficiency is hidden by the fact that incomes are also created by the production of capital goods, or by doing unproductive work, e.g. waging war, &c. As this capital expenditure will enable more and more consumable goods to be produced by less and less labour, we shall eventually reach the absurd position, if we have not already done so, of having to build more and more factories in order that sufficient incomes will be available to buy the production whether the factories are needed or not. We ought to be able to pay the just price of production without having to build things we do not need by having a dividend not charged to production costs. This idea is not new, as many of your readers will know. It was proposed by A. H. Douglas twenty-eight years ago. He saw clearly what was happening. Unfortunately, few were able to understand him or, if they did, it interfered with their conception of things. It would not be good for us. We should become a nation of "spivs" or "teddy boys." Others did not see how it could be done. They accepted what they were told about finance and would not see that the financial system was merely an accountancy system and as such should reflect facts. What is physically possible ought to be financially possible.

I was puzzled about the future in the 1920s, when I was a young engineer on unemployed relief jobs, and saw that the more efficiently I organised my job and the harder I got men to work, the sooner they would be out of a job again. It all seemed so absurd when there was plenty for people to buy, but not enough money. Then I was introduced to Douglas' works and my whole outlook changed. Man was not born for full employment. He was meant to have freedom of choice between good and evil which a private income would assure in the modern world and, if he chose evil he would suffer for it and learn by experience. It was his business and nobody else's. There is a world of difference between employment and work which all sane men enjoy if they are doing the things they want to do. I suggest to Mr. Wright that he should read Douglas and stop being despondent about the future. It is a great help to understand what is happening even if the satisfaction of the full, abundant life is denied us during our life-time.

L. GILLING SMITH, M.I.C.E.

Stockton-on-Tees,
October 29th.

Literature

Symposium on Powder Metallurgy, 1954. Special Report No. 58 of the Iron and Steel Institute, London, 1956. Price £3 5s.

THIS bound volume of the papers contributed to the 1954 Symposium, together with the discussions, both oral and written, is very welcome. It offers the possibility of making a careful examination of the fifty papers presented at this second London Symposium on Powder Metallurgy, and also a comparison with the papers presented and published in Special Report No. 38 covering the First London Symposium. Such a comparison is both interesting and revealing. At that First Symposium there were presented twenty-eight papers covering some 208 pages. In the report of the 1954 Symposium there are fifty papers plus the discussions, and whereas in 1947 all the contributors of papers were of British origin, in the 1954 Symposium fifteen papers out of the fifty presented were of foreign origin.

The scope of the report is very much wider and a very weighty body of information is offered, as may be deduced from the groups into which the papers were divided for convenience of presentation. Each group was presented by a Rapporteur, and in each case it was taken for granted that all interested attenders at the Symposium possessed a preprint of the papers, which could therefore be taken as read.

Subjects were divided into the four following groups :—

Group I, "Manufacture, Properties and Testing of Powders."

Group II, "Principles and Control of Compacting and Sintering."

Group III, "Manufacture and Properties of Structural Engineering Components."

Group IV, "Powder Metallurgy of High-Melting-Point Materials."

With few exceptions the contributions were accounts of original research, including development work, in the period between the first London Symposium and the papers under discussion. Hence this report represents the advances made in the theory and practice of powder metallurgy over a period of seven years. As already mentioned, the discussions which arose have been fully reported, the work as a whole is excellently illustrated by photograph and diagram, there are fully adequate references to literature wherever necessary, and the report probably constitutes the fullest and most comprehensive account available of what British powder metallurgy has achieved in recent years.

ABACS or Nomograms. By A. GIET. Translated by H. D. Phippen and J. W. Head. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 35s.

THE title and the text of this book are renderings of Monsieur Giet's *Abaques ou Nomogrammes*, published in 1954. The authors' intention is to show how nomograms can be constructed, by those without mathematical ability, to evaluate a great variety of formulæ.

The first two parts of the work deal with Cartesian *abaques*, the familiar graphs of the engineer, elaborated by the use of oblique axes and coincident scales to culminate in an example of a nomogram relating the dimensions of a milling cutter and the material of the workpiece to the speed and feed, and the load on the machine. Turning then to parallel co-ordinates, it is shown that a straight line on a graph may be represented by a single point: in the appendix, it is pointed out that although there is an increase in accuracy and a saving in space with a nomogram, the resulting chart cannot be folded and is liable to lose precision with changes in humidity or in reproduction. Three types of chart on parallel co-ordinates are distinguished, those with a third parallel scale, those with scales forming a capital N, and those with a curved scale. The next part deals with *abaques* having intersecting or circular scales, and the last with multiple charts for more than four variables.

The presentation is very largely in the form of examples. There is no index, but a useful feature is a guide to the nomograms appropriate to a range of mathematical relationships.

Books Received

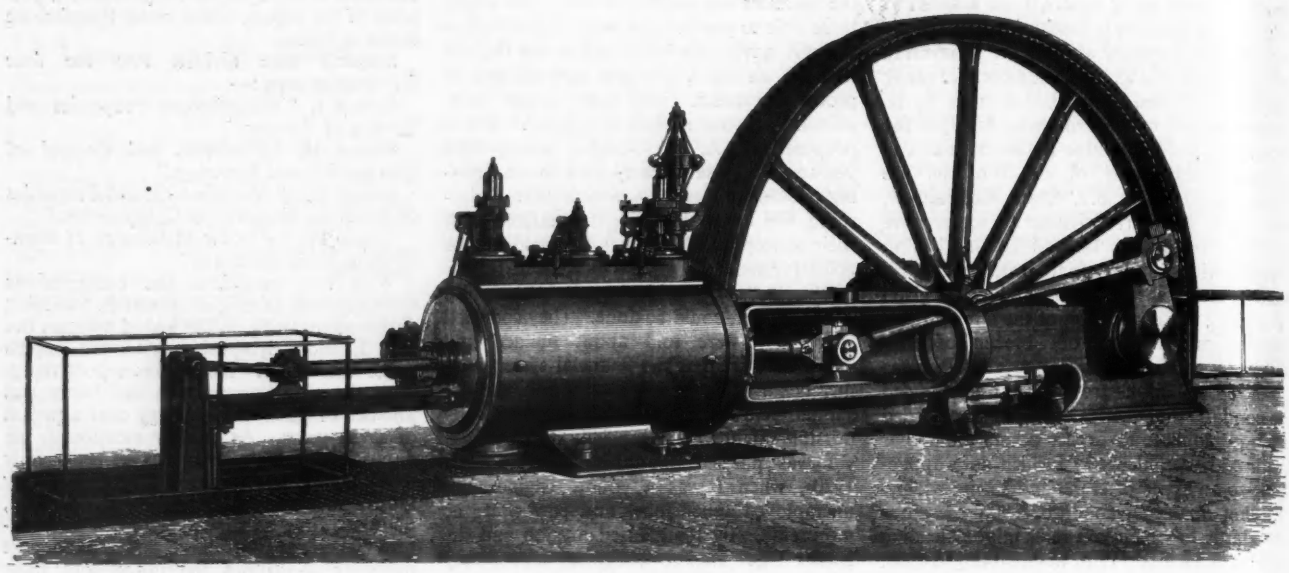
B.B.C. Handbook, 1957. Compiled by the B.B.C., Broadcasting House, London, W.1. Price 5s.

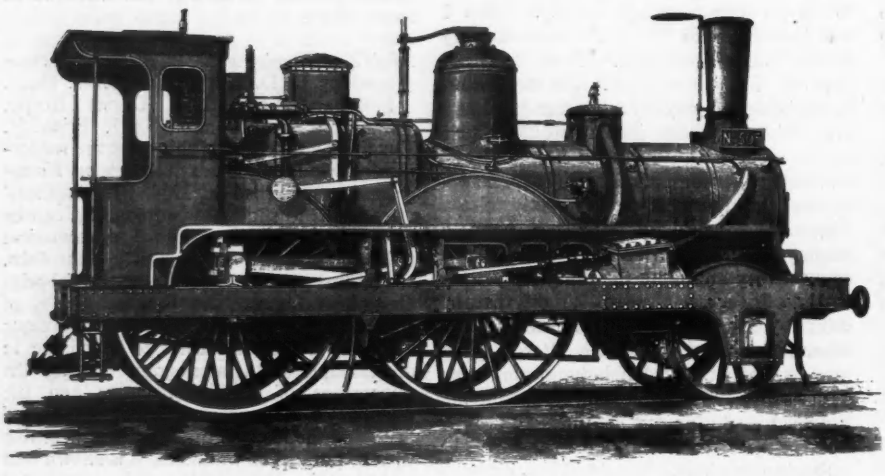
Automation in Theory and Practice. By E. M. Hugh-Jones and Basil Blackwell. 49, Broad Street, Oxford. Price 12s. 6d.

The Fatigue of Metals. By members of the Institute of Metallurgists. 4, Grosvenor Square, London, S.W.1. Price 25s.

Shell Moulding Process. Second report. By J. L. Rice. The Association of Bronze and Brass Founders, 69, Harborne Road, Edgbaston, Birmingham. Price 5s.

ENGRAVINGS OF 1878

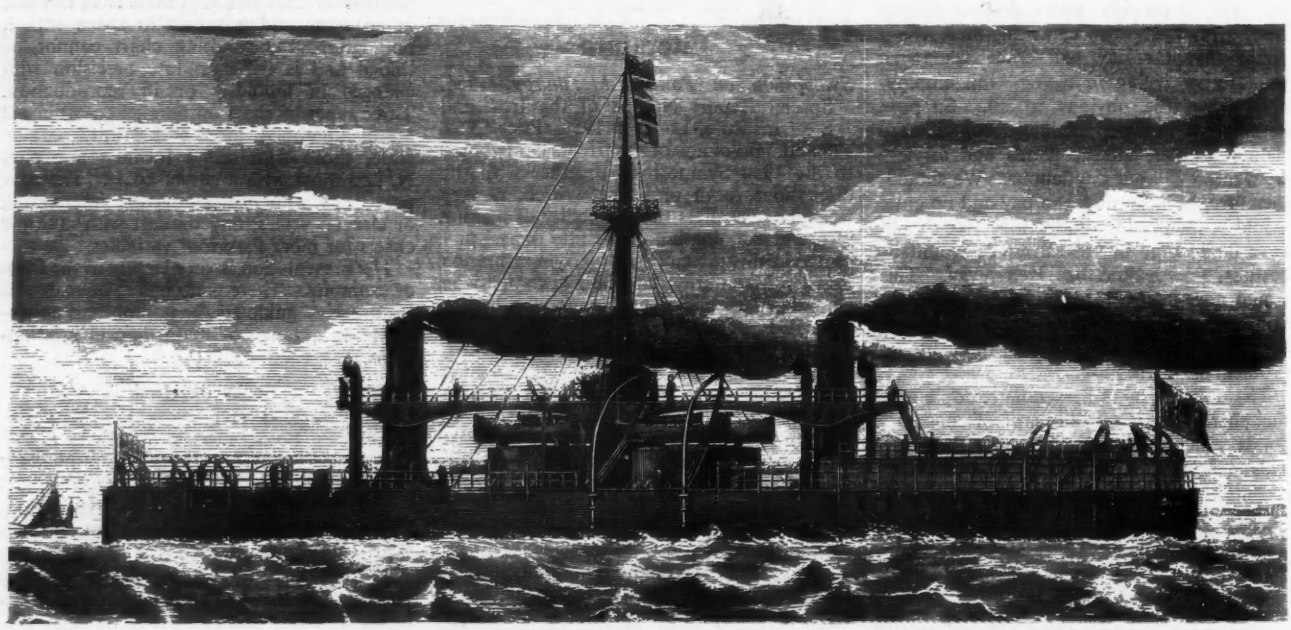




Above, there is reproduced from our issue of August 30, 1878, an engraving of a 230 i.h.p. single-cylinder condensing engine built by Sulzer Brothers, of Winterthur. It was shown at the Paris Exhibition. Its cylinder was 25½in diameter with a stroke of 52½in., the normal speed being 70 r.p.m. Our article says : " we are not aware that any Sulzer engines have been seen in this country."

The express passenger locomotive, for the Eastern Railway of France, which is shown in the engraving (left), was briefly described in our issue of October 4, 1878. Our note about it says : " the engine is of the modified Crampton type, the cylinders being 17¾in diameter by 25in stroke. The driving wheels are 7ft 7in diameter, and the weight of the engine full is 37½ tons."

The Italian ironclad " Duilio " was illustrated in our issue of August 2, 1878, from which the engraving below is reproduced. Our article describes it as " the most powerful warship afloat, if her offensive and defensive capabilities are to be estimated on the basis of the modern theory of naval actions." The length of the ship was 400ft 3in, and her four engines could develop 18,000 h.p., " propelling the vessel at an estimated speed of 16 knots."



Carbonisation and Chemical Plant at Wingerworth

No. II—(*Concluded from page 625, November 2nd*)

The processing plant at the Avenue carbonisation and chemical plant at Wingerworth is designed for an annual production of about 6,000,000 gallons of crude benzole, 13,500,000 tons of crude tar, 18,000 tons of sulphuric acid, and up to 12,000 tons of sulphate of ammonia. In this article particulars are given of the acid, benzole and sulphate of ammonia plants, together with some notes on the effluent treatment plant and the power-house equipment.

The Acid Plant

THE Kachkaroff acid plant which works in association with the gas purification plant was installed by Simon Carves, Ltd., to the designs of the Chemical Plant and Sulphur Extraction Company, and it has a capacity of some 50 tons of acid a day. In this plant the spent oxide from the purifiers is burned so that the sulphur is recovered and the oxide rendered suitable for return to the purifiers without the addition of further revivifying material, when mixed with peat and sawdust.

Each of the two rotary machines used for burning the spent oxide comprises an outer shell of mild steel, lined with firebrick and provided with oxide lifting apparatus, and an inner shell of heat-resisting steel. Spent oxide is fed from an overhead bunker at a controlled rate by a table feeder into a chute leading into one end of the outer shell. Ignition takes place immediately and the oxide and cinder passes slowly down the inclined shell to the discharge point at the far end. The gases produced return via the inner shell to the feed end, where they are conveyed to gas ducts and through a dust removal system before being boosted for entry into the Kachkaroff acid plant.

Here the furnace gases containing 5–6 per cent SO_2 enter a concentration tower and pass in parallel through a denitration tower which is divided vertically into two sections. After cooling in an atmospheric cooler, the gases are drawn through the four reaction towers by means of a fan and finally escape to the atmosphere via a filter tower. All gas flows, other than in the reaction towers, are in counter current to acid circulations maintained over each tower by circulating pump systems.

The basis of the process is the reaction under controlled conditions, between sulphur dioxide, oxygen and nitrous vitriol, when solution and oxidation of sulphur dioxide takes place with extreme rapidity and with almost simultaneous regeneration of the nitrous vitriol. This reaction takes place in the reaction tower system, which comprises the principal acid circuit from which a quantity of acid, equivalent to the production, is continuously bled off to the denitration tower. This acid is fed to one section of the denitration tower and recirculated in closed cycle, together with a measured quantity of water, as the low-temperature of the gas necessitates denitration by dilution. After partial denitration the acid leaving this section, together with a small quantity of acid drawn from the filter tower circuit, is passed over the second section, where, after further dilution, denitration is substantially complete. The heat of the furnace gases entering the concentration tower, with an inlet temperature of 500 deg. Cent., and an outlet temperature of 80 deg. Cent., is utilised for concentration to a strength which may be varied according to the volume of acid in circulation. In addition, the hot gases strip the acid of any remaining traces of nitre, and under correct working conditions the nitrosity of the product acid released from this tower is satisfactory for most purposes. The nitrous acid, which is stable at atmospheric temperature, has a slight vapour pressure at the reaction temperature (30–65 deg. Cent.) and, under normal working conditions, some oxides of nitrogen are carried forward in the gas stream. In addition, a quantity of vesicular acid is also entrained, owing to the disturbance of the liquid surface by the violent reaction at the gas/liquid interface. A filter tower is, therefore, placed at the end of the system, the nitrosity of the circulating acid being maintained at a comparatively low value by bleeding out continuously to the denitration tower and replenishing with fresh acid from the concentration tower circuit. In order to maintain the nitrosity of the nitrous vitriol within the given limits, make-up oxides of nitrogen are introduced to No. 1 reaction tower, by means of an ammonia oxidation unit. Owing to the large reserve of nitre in the system, this unit may be worked intermittently.

Gas Producer Plant

The gas producer installation of the works (Fig. 6) has six Woodall-Duckham Koppers mechanical producers which provide sufficient gas for underfiring thirty-two of the 106 ovens and diluting the purified surplus coke oven gas. Four producers are normally kept in operation, the other two serving as spares. Provision has been made for the extension of the plant by the addition of two further producers, and eventually for the complete duplication of the plant, so that it will be capable of underfiring both batteries of ovens as well as diluting the entire make of coke oven gas.

Fuel for the plant is delivered by belt conveyors to six coke storage hoppers above the producers. Each hopper has a capacity of 30 tons and is divided into two compartments for storing small coke and breeze separately so that the producers may be "sandwich" fired when necessary. Fuel discharged from the hoppers is fed into a measuring chute before being delivered to the producer beneath. A revolving feed equipment at the top of the producer admits and regulates the supply of fuel and maintains uniform gasifying conditions. This feed arrangement consists of a preliminary cast iron charging chamber, sealed at the top with a gas-tight cover and at the bottom with a hand-operated discharging cone by means of which a definite quantity of fuel can be fed into distributing chutes. The charging chamber, together with its distributing arms, is rotated slowly from the main producer driving shaft, and spreads the fuel evenly over the surface of the fuel bed.

The upper part of the producer is of mild steel lined with firebrick and its lower part embodies an annular boiler which supplies low-pressure steam for saturating the air blast and other requirements. A mild steel skirt at the bottom of the producer shell seals it in a water-sealed ash bowl. The rotating grate of cast iron sections forms an eccentric cone, the apex of which extends upwards into the producer. This grate is stepped, with slots in the vertical steps through which the air blast enters. It is mounted on a cast iron plate which forms the base of the ashpan and which carries the tracks upon which both grate and ashpan rotate. The underside of the grate has a skirt plate, water-sealed against air blast in a cast iron annular trough. Gas leaving each producer passes to a Whessoe hurdle-filled gas cooler.

Four sets of combined air blowers and gas exhausters are provided to supply air under pressure for the producer grates and to boost the producer gas for underfiring the ovens. Two motor-driven sets are normally in operation, one serving each set of three producers, whilst two turbine-driven sets act as standbys. Each air blower is capable of handling 470,000 cubic feet of air per hour and each gas exhauster 670,000 cubic feet of gas per hour. These exhauster and air blower sets are situated in a fan room in the producer house together with the feed water pumps and two boosters which are provided for gas dilution and have a capacity of 175,000 cubic feet of gas per hour each. A single-lift gas holder of 100,000 cubic feet capacity is provided to serve as a reservoir for gas during flow reversals at the ovens.

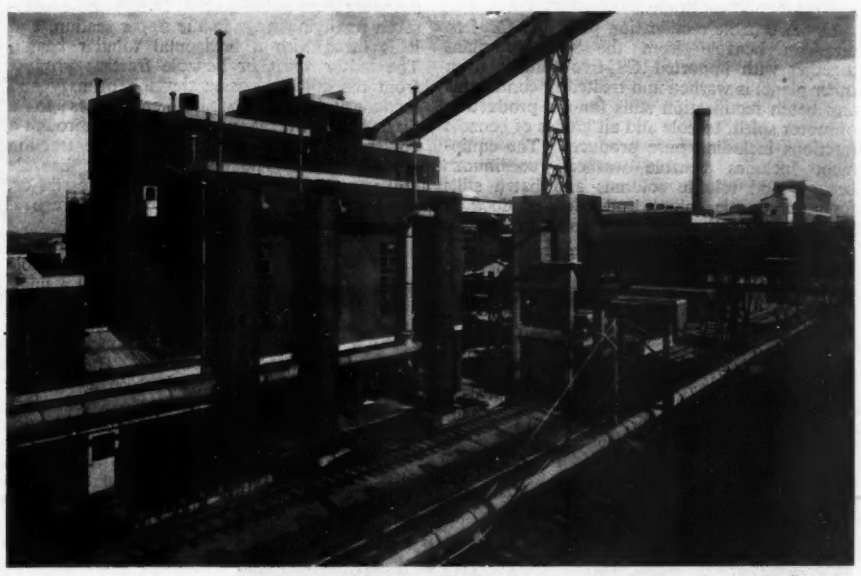


Fig. 6—Producer house with producer gas washers

Benzole Recovery Plant

The benzole recovery section includes equipment for the recovery of crude benzole and the production of a CS_2-free, once-run, product and heavy naphtha oils. The three benzole scrubbers provided to scrub the crude benzole from the gas normally operate in series but are so arranged so that any one can be by-passed. Wash oil from the scrubbers, enriched with benzole, is passed through two vertical tube vapour-to-oil heat exchangers in which heat is transferred from the crude benzole vapours leaving the still to the benzolised wash oil. The enriched wash oil is then steam-heated in two final heaters before entering a still where the crude benzole is removed by intimate contact with steam. A small portion of the debenzolised wash oil is

passed through a purifier for conditioning and the hot oil from the still is pumped through a wash oil cooler before recirculation to the scrubbers.

Crude benzole vapour leaving the still through the vapour-to-oil heat exchangers passes to an open cooler where it is cooled and condensed. Crude benzole from this cooler is then passed through a separator for the removal of water before being delivered to a continuous CS_2 column.

This CS_2 column, of cast iron construction, has a tubular heater and consists of a bottom portion with thirteen stripping sections, and an upper portion with twenty-seven rectifying sections and a reflux chamber. In the column the CS_1 is removed from the benzole which is then passed by a lifter to a once-running column. The CS_2 passes through a condenser to a decanter where the water is separated. A portion of the CS_2 is then returned to the reflux chamber and the remainder is loaded into road tankers from an overhead tank.

The continuous once-running column for the benzole has eight stripping sections with six rectifying sections above and a reflux chamber. In this column the CS_2-free benzole is treated and, after passing through a condenser and decanter for water separation, the product is pumped through storage tanks to the benzole column of the rectification plant. The residue from the once-running column is passed by a lifter to the heavy naphtha column, from which the heavy naphtha product passes through a condenser to a receiving tank and then is pumped to the tar plant. The residue from the column also passes to a receiving tank for delivery to the tar plant.

Two concrete intercepting sumps with a total working volume of 640 cubic feet are provided to separate any oil from the water returned from the crude benzole and rectification plants, separators and oil drains.

In the benzole rectification plant the CS_2-free once-run benzole from the recovery plant together with imported CS_2-free benzole from other plants is washed and treated in continuous and batch rectification stills for the production of motor spirit, toluole and all grades of benzole fractions including pure products. The equipment includes benzole washers, continuous benzole and toluole columns and batch stills for pure benzole, toluole and xylole production. For the production of motor spirit or benzole fraction the product from the once-run column is washed with acid and soda in benzole washers before being pumped through a preheater to the continuous benzole column.

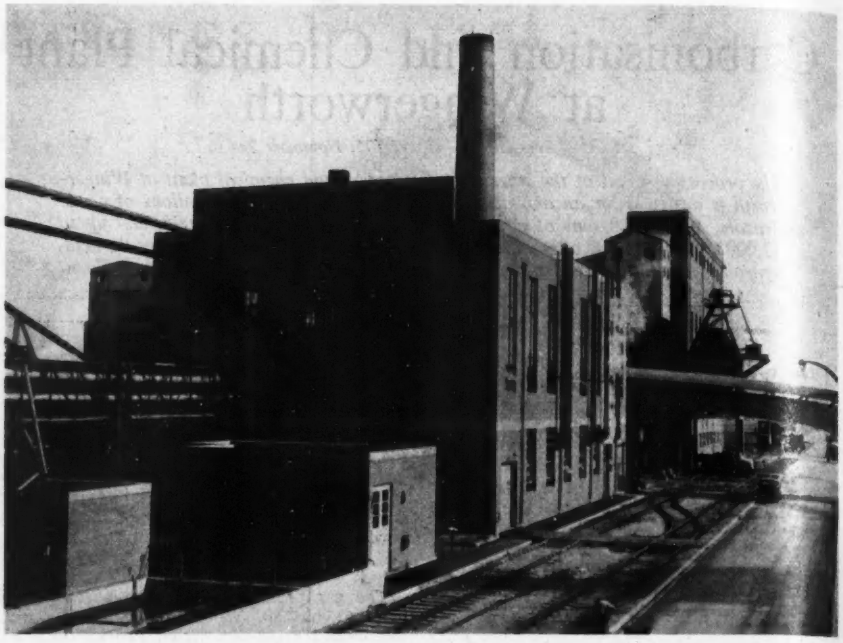


Fig. 8—Power house at Avenue Works. The boiler house can be seen in the background

This continuous benzole column has ten stripping trays in the bottom section and twenty-seven rectifying trays in the upper section, and it is fitted with a horizontal tubular heater. The motor spirit or benzole fraction product from the column passes through primary and secondary vertical tubular condensers to a decanter for water separation and on through a cooler to the motor spirit or benzole fraction storage tanks. The residue from the benzole still is passed by a lifter to the toluole still or, alternatively, through a cooler to storage if rewashing is required before redistillation.

The toluole column is similar to the benzole column and has a single condenser, a decanter and coolers for the toluole fraction and xylole residue. The toluole fraction passes to the storage tanks from which it can either be loaded to tank wagons or pumped to the benzole washers and on to the toluole batch still for redistillation. The xylole residue from the toluole column passes through a cooler to storage for treatment in the benzole washers and the xylole batch still.

There are two benzole batch stills, each with a capacity of 12,500 gallons, in which the washed benzole from the continuous column is re-run. There is also a toluole batch still of the same capacity normally used for the redistillation of the washed toluole fraction, and a still of 8300 gallons capacity for the production of pure xylole. If desired, any product can be produced in any of these stills.

The acid sludge from the benzole washers is passed to a treater, where it is mixed with creosote oil and water and is then agitated with steam admitted at the base of the treater. After a period of agitation in this treater, the mixture is allowed to settle and the regenerated acid is run off to collecting tanks and the remaining acid-contaminated creosote oil is then treated with soda solution and further steam agitation. The neutralising liquor is run off to a waste tank and the remaining creosote drained off and passed to the tar plant. The benzole in the vapours leaving the treater is recovered in a tubular condenser and passed to a tank, from which it is pumped to the benzole agitators.

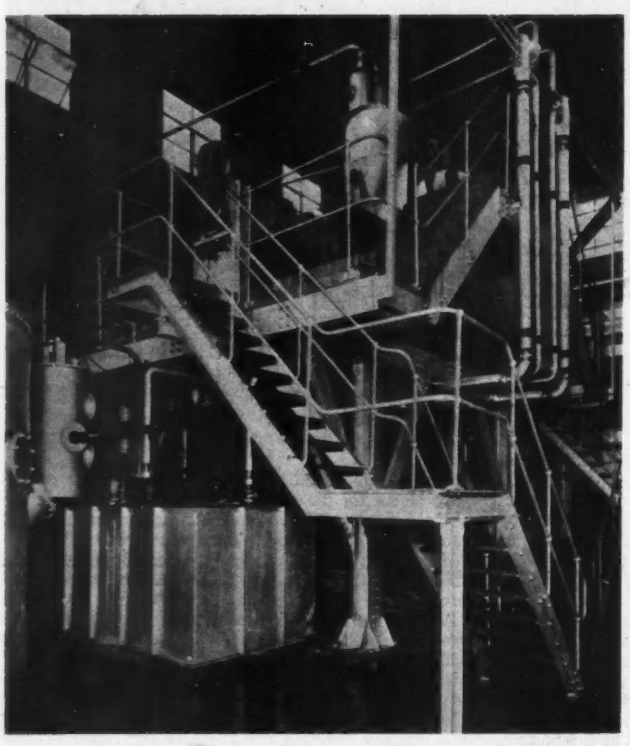


Fig. 7—Interior of sulphate plant house

Sulphate of Ammonia Plant

The sulphate plant (Fig. 7) includes equipment for dealing with ammonia liquor recovered in the by-product, purification, tar and effluent plants, and also concentrated liquor imported from other sources. The total capacity of the plant in terms of liquor throughput is 7000 gallons per hour, the maximum production of sulphate therefrom being in the region of 45 tons per day. The plant has two ammonia liquor storage tanks, each of approximately 200,000 gallons capacity, which receive ammonia liquor from the strong liquor compartment of the liquor sump and also condensates from the gas purification plant, effluent from the tar plant, and recirculated ammonia liquor from the effluent plant. Tar is run off at intervals from the base of these tanks into a concrete underground sump, whence it is pumped to rail tanks for delivery to the tar plant.

Two cast iron ammonia stills for separating the ammonia from the crude liquor each have a capacity of 4500 gallons per hour and comprise "free" and "fixed" compartments operating as separate units. The free compartment incorporates eight trays complete with bubbling hoods, overflows and vapour uptakes, and has below a lime compartment, complete with a steam nozzle and baffle, and an outlet for the removal of sludge. Ammonia vapour leaving the top of the free compartment passes to a saturator, whilst the residual lime-treated ammonia liquor passes via a seal to the fixed compartment. This fixed compartment has nine trays and vapour from it is passed to a dephlegmator-condenser, one of which works in conjunction with each still. The condensate from the dephlegmator is returned to the still as reflux, whilst the concentrated ammonia liquor from the condenser passes to a receiving tank, from which it can be pumped either to the

effluent plant or to the ammonia liquor storage tanks.

Ammonia vapour from the free compartments of the stills is passed to a "Royston" saturator for the production of ammonium sulphate in the form of large crystal salt. After leaving this saturator the ammonium sulphate passes to crystal separators, where the excess liquor is drained off and returned to the saturator. The wet crystal sulphate is then dried, first in centrifugal driers and then in a flash drier which incorporates means for the introduction of concentrated ammonia liquor and steam, to neutralise the acidity of the sulphate. The dry crystals are delivered to a sulphate bagging hopper fitted with an automatic weighing machine from which the bags are taken to a sulphate store.

Effluent Treatment Plant

The disposal of noxious effluent from a works of this kind presents a problem of some magnitude and for this purpose a new processing plant, the first of its kind, has been installed. This plant is based upon the work carried out on a pilot plant at the Corby works of Stewarts and Lloyds, Ltd., which was the outcome of co-operative research between the Permutit Company, Ltd., the Woodall Duckham Construction Company, Ltd., and Stewarts and Lloyds, Ltd. It is designed to purify the noxious effluent from the sulphate plant (which contains calcium chloride, thiocyanate, thiosulphate and organic compounds, including phenols and tar acids), using the ion exchange process, augmented by an activated carbon filtering plant. The new plant has been designed to purify up to 185,000 gallons of liquor daily. It removes thiocyanates and thiosulphates and concentrates them into a volume of 1·1 per cent of that of the inlet liquor for easy disposal. In addition, the monohydric phenols are recovered and passed to another section of the coke works for final purification. Every measure has been taken to ensure that the maximum volume of ammonia, hydrochloric acid and benzole are recovered and distilled, where necessary, for further use, thus reducing the make-up requirements.

In the first stage of purification hot untreated effluent is passed into one of two 62,000-gallon sedimentation tanks, and after settling it is pumped through a cooler to a sump. From this sump the cooled liquor is pumped through a battery of four sand filters and is then dosed with hydrochloric acid to lower the pH to a suitable value for ion exchange treatment. The thiosulphates and thiocyanates in the liquor are then removed by a battery of three ion exchange units containing "De-Acidite" ion exchange material. When the capacity of this material is exhausted, the accumulated inorganic salts are removed by flushing with ammonia solution. The free ammonia in this reject liquor is recovered by distillation in a separate ammonia distillation plant. Reject liquor from this distillation plant is concentrated to a small volume in a submerged flame concentrator which reduces the bulk to about 1 per cent of the effluent treated.

The treated liquor is collected in a storage tank and pumped through a battery of carbon filters which remove the monohydric phenols and higher tar acids. When the carbon in these filters becomes saturated the phenols and tar acids are removed by treatment with benzole. The majority of this benzole is recovered in a separate benzole distillation plant. The reject liquor from this distillation plant, consisting of phenols and tar acids and a small proportion of benzole, is worked up in a separate part of the coke works.

Effluent from the carbon filter units is treated with lime before being discharged as a colourless inocuous solution into the works drain system.

The continuous tar distillation installation supplied by Chemical Engineering Wiltons, Ltd., has been designed to process the crude tar from this coking plant as well as that from neighbouring coke oven installations of the Coal Board. It has at present a capacity of 200 tons of crude tar every twenty-four hours, with provision for doubling this capacity at a later date. In this plant crude tar is fractionated to pitch and benzole, solvent naphtha, carbolic oil, naphthalene oil, creosote, and anthracene oil. Part of the pitch produced is used for the manufacture of pitch creosote blends or road tars and open bays are also provided for its storage in solid form. Harder pitch can be provided when required and, when the demand for pitch falls, provision is made for its use in blending fuel for burning in the steam plant of the works.

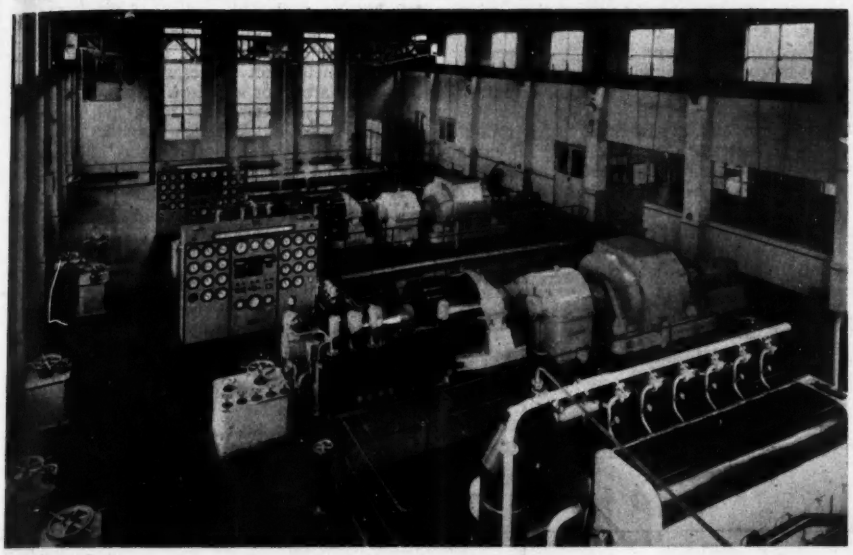


Fig. 9—The turbine room in the power house, showing the two 5000kW twin-cylinder, pass-out turbines and gearing, and the top of the diesel engine generating set in the foreground

Power Plant Installation

All of the low pressure steam and most of the electric power required in the plant is supplied from the power house and boiler installation shown in Fig. 8. In this respect it is of interest to note that in order to maintain balanced conditions throughout the works practically all of the pumps, fans and other equipment serving the various plants are duplicated and provided with alternative electric motor or steam engine drives. The decision to use either the steam or electric drive in any section is made by the power plant engineer, who is thus able to maintain balanced conditions at all times.

The steam raising plant supplied by Babcock and Wilcox, Ltd., comprises three boilers, each rated for a maximum continuous output of 60,000 lb of steam an hour at 475 lb per square inch and 640 deg. Fah., when fed with coke breeze having a net calorific value of 9200 B.Th.U. per lb with approximately 22 per cent moisture and 11 per cent ash content. These boilers are fitted with the maker's air recirculation system, developed to maintain ignition when burning coke breeze without the addition of high volatile fuels, and they are stated to be the largest of their kind in this country.

The power plant was supplied by W. H. Allen Sons and Co., Ltd., and includes two steam turbines which, in order to achieve the maximum flexibility of the supply to suit varying steam and power demands, are provided with a condensing section so that any power required additional to that generated from the pass-out steam can be produced. A reducing valve is fitted in parallel with the turbines in case the low-pressure steam demand is greater than that necessary to meet the electric power demand at any given time.

The turbines are each designed for a power output of 5000kW, and a pass-out steam quantity of 95,000 lb per hour with a condenser suitable for 40,000 lb per hour at 28in Hg vacuum, and permitting 3000kW to be generated with no pass-out flow. The machines are of the twin-cylinder, multi-stage, impulse, geared design, with the cylinders arranged in tandem and the pass-out branch at the end of the h.p. cylinder, the l.p. cylinder acting as the condensing end.

In addition to a leverless oil-relay constant-speed governor, each turbine is fitted with pass-out governor gear designed to maintain a constant pressure at the pass-out branch, irrespective of changes of load or demands for low-pressure steam. A number of automatically-operated nozzle-control valves are provided to ensure maximum economy of steam at all loads and throttle flows, by maintaining the pressure upstream of the turbine nozzles at the highest possible figure, thus avoiding throttling. The speed of the turbine can be adjusted locally by hand or, alternatively, by a small motor controlled from the main switchboard.

The turbines run at 4000 r.p.m. and are geared down to 1000 r.p.m. to drive English Electric alternators wound for a 3300V, 50 c/s, three-phase supply. In the power house, illustrated in Fig. 9, both the h.p. and l.p. steam-pipe systems are arranged in the form of a ring main and valved so that in the event of an overhaul to either turbine or any section of pipe, an uninterrupted supply of power and steam can be maintained to the site. A "Hagan" reducing valve and its associated desuperheater is designed for a maximum discharge into the low-pressure steam mains of 75,000 lb per hour. The valve is tight-shutting, and de-superheating is effected by injecting the cooling water directly into the steam main. Also to maintain a constant superheat of only 50 deg. Fah. in the low-pressure steam, a "Hagan" spray-nozzle desuperheater is fitted in both legs of the low-pressure steam main at the point where they leave the building.

A 500kW diesel-alternator set, which is installed to provide power for the initial starting-up of the plant, is also arranged to start automatically upon failure of the power supply from the turbo-alternator. This Allen six-cylinder, vertical, airless-injection, compression-ignition two-stroke engine, drives an English Electric alternator at a speed of 375 r.p.m., the alternator being similar to the turbine-driven units.

Power is distributed from the power house in three separate systems, 3300V a.c., 415V a.c., and 220V d.c. The supply from the alternators is taken to a seventeen-panel, high-voltage oil circuit-breaker switchboard of Allen West manufacture, having a breaking capacity of 100MVA. This board feeds two house transformers, and two mercury-arc rectifiers, and also provides a high-voltage supply for the coal handling plant, water-cooling plant, by-product plant and coke handling and producer plant.

Car-Sleeper Expresses on French Railways.—It is announced by French Railways that next summer it is proposed to introduce a car-sleeper express, which will run between Boulogne and Lyon three times a week in each direction. With this service passengers will travel in couchettes or sleeping berths and their motor cars will be conveyed on wagons on the same train.

High Voltage Glass Insulator Laboratory

A new high-voltage insulator laboratory at the Ravenhead works of Pilkington Brothers, Ltd., St. Helens, Lancs, was opened on November 2nd by Lord Citrine, chairman of the Central Electricity Authority. The main test plant consists of an impulse generator with a nominal voltage rating of 2300kV, a 2m sphere gap and two 650kV power-frequency transformers connected in cascade to give an output voltage of 1300kV. A short description of the laboratory is given here.

LAST week Lord Citrine, the chairman of the Central Electricity Authority, opened a new high-voltage insulator laboratory at the Ravenhead works of Pilkington Brothers, Ltd., St. Helens, Lancs. The laboratory is designed for the testing of insulators up to the highest transmission voltages at present envisaged. To appreciate the significance of this laboratory in a glass works it may be useful to begin by briefly reviewing the development of toughened glass insulators by Pilkington Brothers, Ltd.

This history goes back to the early 1930s, when the company was seeking new outlets for glass as a raw material—a search which was intensified by the dwindling demand for battery boxes which, for many years, until the advent of the mains receiver, had absorbed much of the productive capacity of the Ravenhead works. It was at about this time that the company began to examine the possibilities of glass for electrical insulators. It was felt that glass might be advantageous as a material for insulators on high-voltage lines provided that it could be manufactured with mechanical and other properties to match its good electrical properties. A beginning was made with glass insulators for telephone lines and cap-and-pin insulators for overhead lines at voltages such as 3·3kV and 11kV. But for higher voltages, and in particular for the main Grid transmission lines using strings of insulator discs, annealed glass proved to be mechanically unsatisfactory. At about this time the toughening process for making safety glass for the motor industry had been established. By applying similar methods to heavy articles of varying thicknesses of glass, it was found that glass insulators could be strengthened to withstand considerable mechanical shock. Now, after two decades of development, toughened glass insulators made by Pilkington Brothers, Ltd., are in service on power lines at voltages up to 380kV in climatic conditions varying from equatorial to arctic.

Prior to the building of the high-voltage insulator laboratory at the St. Helens works, most of the high-voltage testing was done by outside firms and, in particular, by Metropolitan-Vickers Electrical Company, Ltd. Eventually, however, the demand for testing facilities grew to such a point as to justify a laboratory solely for electrical research and testing.

The high-voltage laboratory at the Ravenhead works is designed to fulfil three main functions. First, to carry out research and development with the aim of improving the performance of toughened glass insulators and insulator strings. Secondly, to give customers a full technical service relating to insulators for their systems and to provide means for confirming that insulator string arrangements offered will meet the customers' specifications. Thirdly, to allow electrical and mechanical tests to be made in accordance with B.S. 137, or national test requirements, or any future international specifications for glass insulators.

Briefly, the equipment consists of an impulse generator with nominal voltage rating of 2300kV, a 2m sphere gap, and two 650kV power-frequency transformers connected in cascade, giving an output voltage of 1300kV. These three pieces of equipment are arranged in line along the eastern half of the main hall with the sphere gap in the middle so that it is convenient for the impulse generator and the testing transformers, as shown in Figs. 1 and 3. Building clearances are sufficient to permit the voltage of the impulse generator being increased to 2850kV at a later date should this prove necessary. These facilities should be sufficient for work on insulators at the highest foreseeable overhead line voltages. To provide clearances for such developments the main building is a large hall 120ft long by 80ft wide, by 60ft high. The main clearances are as follows: a sphere of 30ft radius at a height of 33ft for the impulse generator; a sphere of 30ft radius at a height of 41ft for the power-frequency plant, and a sphere of 28ft radius at a height of 30ft for the sphere gap.

The western half of the main hall is divided by high metal safety fences with safety interlocks, into test areas for impulse and power frequency working. Adjoining the main hall is a two-storey office block which provides the main entrance to the laboratory and contains, on the second floor, a sound-proofed room with double-glazed observation windows overlooking the main hall. Annexes around the main hall accommodate various items of mechanical testing plant and a dark room, a substation and storage space.

Natural light is admitted through 2500 square feet of vertical glazing, built into the top of the side walls. For general work good natural light is required over the whole of the test area floor, and good upward vision towards the suspended test objects, but certain testing, such as corona

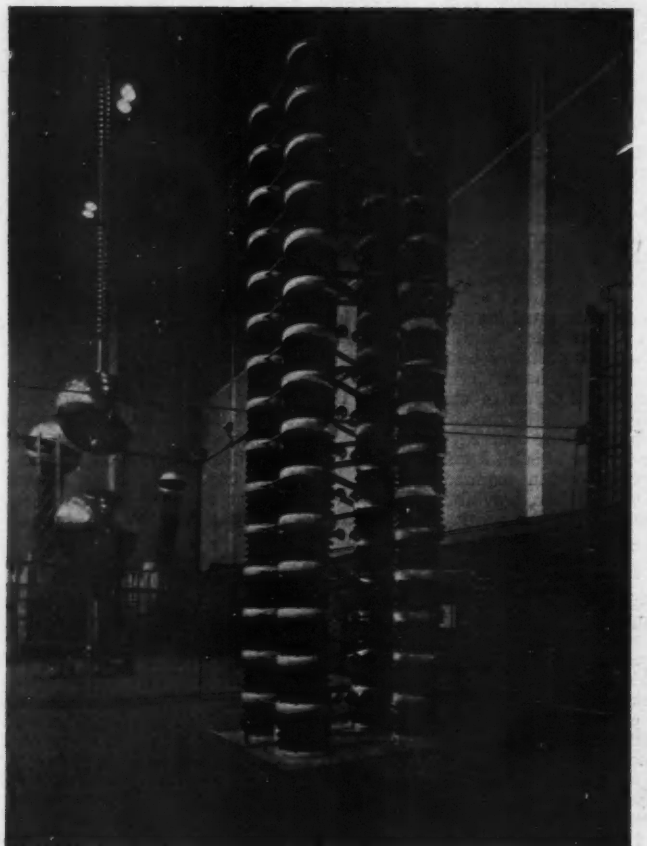


Fig. 1—The 2300kV impulse generator shown here has a conventional fourteen-stage circuit, each consisting of two 0·075 microfarad condensers in parallel, the maximum charging voltage being 170kV on either polarity

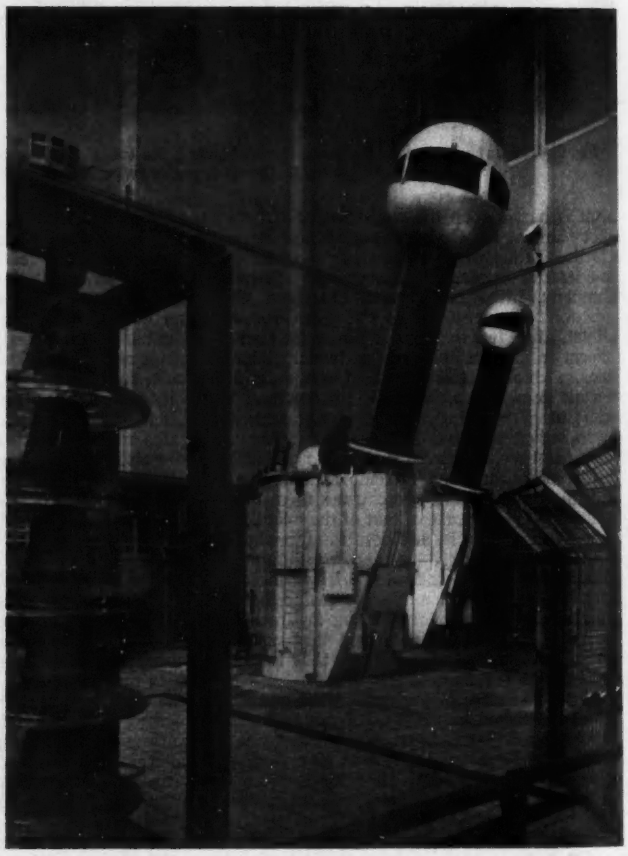


Fig. 2—Power frequency test voltages up to 1300kV are obtained from two 650kV transformers connected in cascade. The voltage of each transformer is continuously variable between 14kV and 650kV

observation, has to be done in complete darkness. The required black-out is effected by means of electrically-operated blinds over the clerestorey glazing; these blinds are controlled from the floor and the building can be made completely dark in fifteen seconds. The doors are weather-stripped to prevent light leakages. The main artificial lighting is from high-power downward reflectors recessed into the ceiling. To counteract the glare from these reflectors, wall-mounted lights are arranged to flood upwards, illuminating the ceiling itself.

The heating requirements of the building are unusual because of the very large volume of the main hall and because some of the test apparatus at high level has to be kept dry, despite the fact that artificial rain sprays are used in certain of the tests. To meet these requirements high-temperature radiant heat is provided by groups of radiant gas heaters mounted high on the walls, as can be seen in our illustrations.

The laboratory equipment is so disposed that high-voltage tests can be carried out with either impulse or power-frequency voltages on strings of insulators arranged vertically or horizontally, as required. Vertical insulator strings are suspended from the ceiling and can be raised or lowered by electrically operated hoists controlled from ground level. Horizontal strings of insulators are stretched across the laboratory by 3-ton winches, the cable ends being anchored to wall stanchions with fittings whereby the height of the insulator string can be adjusted up to 40ft above floor level.

Wet or dry tests can be done at either impulse- or power-frequency voltages on horizontal or vertical insulator strings. For the wet tests artificial rain can be fed to sprays hung from the ceiling. Before being pumped through the sprays the mains water is passed through a demineralising plant so that the electrical conductivity of the artificial rain spray can be controlled.

For impulse testing, impulse voltages with a maximum peak value of 2300kV are generated through a conventional fourteen-stage impulse circuit, each stage consisting of two 0·075 μF condensers in parallel, the maximum charging voltage being 170kV on either polarity. When the condensers are triggered in series the generator is discharged and the output voltage appears across a wave front condenser of 235 μF, which also constitutes the high-voltage unit of the capacitor potential divider from which all connections to the test objects are made. All the earth connections in the impulse circuit terminate at the foot of the potential divider, which is the reference point for all impulse voltage measurements. Normally the generator produces a 1/50 microsecond wave, but variations in wave shape can be obtained by the choice of suitable values of wave front and wave tail resistances; in particular a 1½/40 microsecond wave can be produced in this way. Tripping of the generator is effected at a predetermined charging voltage by an electronic tripping circuit. The same circuit also produces the tripping pulse for the cathode-ray oscillograph, with a controlled variable time delay between the two pulses.

The standard of voltage measurement is provided by a 2m diameter sphere gap (Fig. 3), whereby peak voltages are measured in accordance with B.S. 358. The upper sphere, which is live, is suspended from the ceiling by a long insulator string and coarse adjustment of the height can be made with a hand winch at floor level. For fine adjustment of the sphere gap the height of the lower sphere, which is earthed, can be adjusted by a motor-driven screw.

Impulse voltage measurements can, alternatively, be made by the capacitor potential divider, in conjunction with a sealed-off cathode-ray tube (Fig. 4), the oscillographic records being made on 35mm film which can be processed in the laboratory dark room. While a test is in progress any adjustments of charging voltage, impulse generator sphere gap, or 2m sphere gap can be made from the control desk (Fig. 4), upon which remote indication is given of the shere gap spacings.

For power frequency testing, alternating voltages up to 1300kV r.m.s. can be obtained from two 1200V/650kV transformers (Fig. 2) con-

Fig. 3—Tension insulator string being assembled for testing in the high-voltage laboratory. (Left) 2m sphere gap. (Centre) 2300kV impulse generator with capacitor potential divider on its right

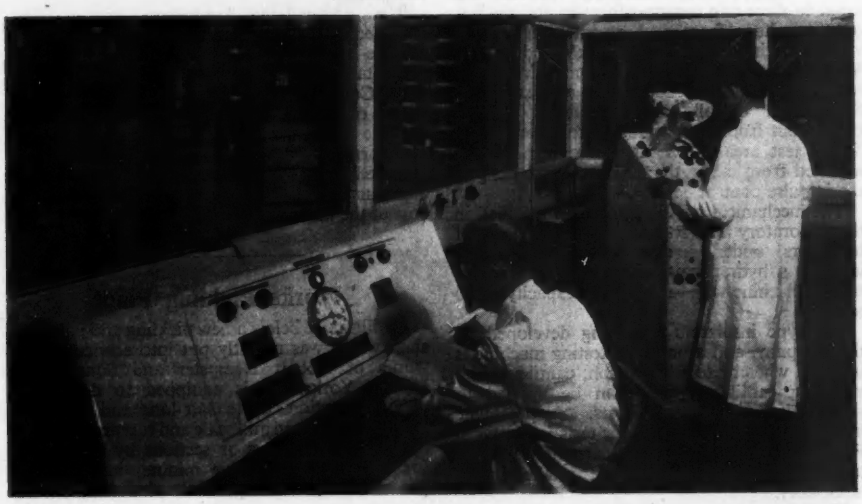


Fig. 4—Impulse generator control room. Adjustments for charging voltage, settings of generator sphere, gaps and 2m sphere gaps are done from the control desk on the left, and test results are recorded by the oscillograph on the right

Fig. 5—Thermal cycle test room. Insulators in metal cages can be transferred quickly by motorised pulley blocks from a pair of tanks at 96 deg. Cent. to another pair at 1 deg. Cent

Fig. 6—Post type insulators are under development. A prototype assembly is here shown undergoing cantilever load test in a machine which can be used for tension, torsion and vibration cantilever tests on single or multi-post insulators

nected in cascade, with one transformer insulated from earth for 650kV. A motor-generator set and a tapped auto-transformer provide the input to these two test transformers and the h.v. output voltage from each transformer can be varied continuously between 14kV and 650kV. Voltage measurement is done from a voltmeter winding, the 2m gap being used as a standard. Supervision of all power-frequency tests is carried out from a separate control room in the 50 c/s test area. The 2m sphere gap can be adjusted from either the 50 c/s control desk or the impulse control desk.

The mechanical testing equipment installed in the laboratory for studying the behaviour of insulators under service loading conditions includes a hydraulically operated Avery tensile testing machine with a maximum capacity of 50 tons.

Post-type insulators are being developed by the company, and a universal testing machine is installed whereby tensile, torsion, cantilever and vibrating cantilever loads can be applied to single-unit or multi-unit posts. A prototype insulator undergoing cantilever tests is shown in Fig. 6. Additional plant for carrying out long-term mechanical testing is to be installed in the laboratory.

The high-voltage laboratory is also responsible for various other studies of factors affecting the construction and performance of insulators. This work includes sample testing of each consignment of the aluminous cement used in the assembly of the glass insulator elements and the associated metal fittings. Sample testing is also done on the galvanising of all ferrous metal fittings to ensure that the requirements of B.S. 729 are satisfied. Finally the thermal cycle testing of insulators can be carried out in a room equipped with four water baths arranged in pairs (Fig. 5). Two of these baths can be heated to temperatures up to 96 deg. Cent. and the other two can be cooled down to 1 deg. Cent. to cover the range of temperature difference demanded by various national specifications. Thermal cycle testing is done by loading the insulators in metal cages as shown in Fig. 5, and by rapidly transferring the loaded cages alternately from the hot to the cold baths, with the help of the motor-driven pulley blocks which can be seen in the illustration.

For the time being the laboratory is likely to be fully committed to a programme of development and test work. It is pertinent to observe, for example, that the company has been awarded the insulator contract for the Kariba Gorge scheme, which will require a total of about 300,000 insulators for the total length of nearly 1000 miles of 330kV overhead transmission lines. In due course, however, it is likely that the facilities of the high-voltage laboratory may be available for contract work or for co-operative research work in conjunction with various authorities.

The high-voltage laboratory project was designed by Mr. E. F. Johnston and his colleagues on the staff of Pilkington Brothers, Ltd., in consultation with Metropolitan-Vickers Electrical Company, Ltd., which supplied the main items of electrical equipment, including the impulse generator and the power frequency transformers. The laboratory building was designed by Mr. C. C. Handisyde, A.R.I.B.A., and was built by Bovis Ltd., the total installed cost of the laboratory being about £200,000.

Works Pickling Plant

WE illustrate below a new pickling and painting shop which was recently put into service at the works of Robert Dempster and Sons, Ltd., Elland, Yorks. It is equipped to deal with plates or sections up to 34ft long and 7ft wide. In the process used mill scale and rust are removed from the steel plates or sections by immersion for fifteen to twenty-five minutes in a 5 to 6 per cent sulphuric acid bath at a temperature of 65 deg. Cent. After the work has then been drained it is washed by two dips in a heated water bath before being immersed in a phosphoric acid bath. This bath is maintained at a temperature of 85 deg. Cent. and contains 2 per cent free phosphoric acid with 0·3 to 0·4 per cent iron. This final immersion produces a rust inhibiting coat of iron phosphate over the whole surface of the steel which, when dry but still warm, is painted with a priming coat.

The new shop is 200ft long by 52ft wide and has three pickling baths 35ft long, 5ft wide and 9ft deep arranged down one side. Each bath is heated by four steam injectors and its contents can be emptied by steam ejectors from a sump at one end. Spent pickling liquid is treated in an effluent plant before being discharged into the sewers.

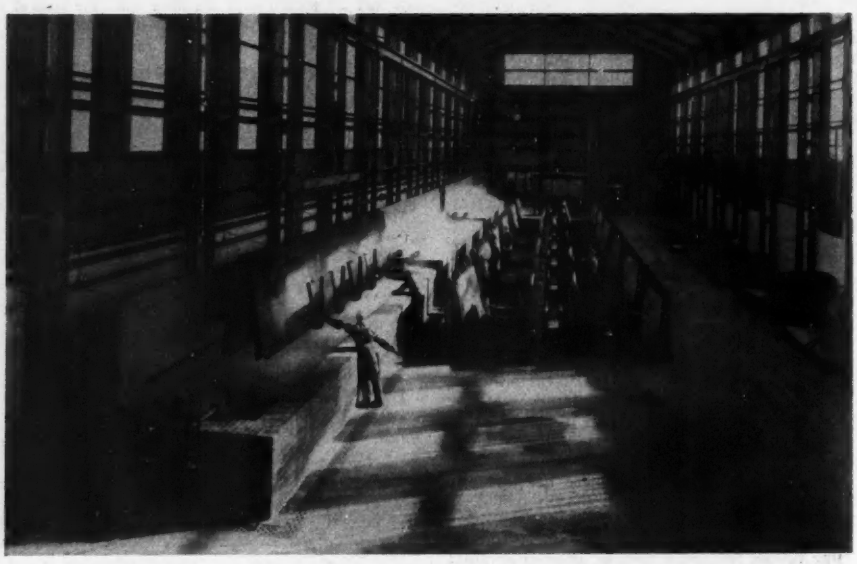
A 10-ton overhead electric crane which serves the full length of the shop is used with a range of special lifting tackle to handle the various forms of work between the baths and the painting racks. Large extraction fans draw the fumes through ducting at the rear of the baths and another set of fans on the other side of the shop which deliver hot or cool air across the floor towards the baths maintain satisfactory atmospheric conditions for the operators.

Technical Report

Road Note No. 21 : *Tests on the Efficiency of a Twin-Shaft Paddle Mixer with Various Settings of the Paddle Tips.* H.M. Stationery Office. Price 1s. 6d.—The Road Research Laboratory has found comparatively large differences in composition between samples taken from various parts of a single batch from a commercial asphalt or tarmacadam mixer. Road Note No. 21 describes a thorough investigation of this phenomenon, using a twin-shaft paddle mixer. The effect on the mixer's efficiency caused by various settings of the paddle tips was investigated.

A special apparatus for taking samples from different positions under the mixer door was developed for the work. The mixer used was the Laboratory's 20 tons per hour mobile asphalt plant, and paddle arms with adjustable tips were fitted to it. Comparisons between different paddle settings were made by studying the general variation in percentage of binder, fines and filler throughout the batches, the distribution of tracer material and the systematic variations in the percentage of constituents along the length of the mixer.

The experiments showed that the most satisfactory type of mixer was one in which the mix was rotated in a horizontal plane by suitable setting of the paddle tips. The " end-to-end " action given by this setting was superior to the setting giving an " ends-to-middle " action.



Modern works pickling and painting shop for steel plates and sections

Electrical Drive for Five-Stand Tandem Cold Mill at Velindre

A five-stand tandem cold reduction mill is being built by Davy and United Engineering Company, Ltd., at the Velindre works of the Steel Company of Wales, Ltd. The electrical equipment for the main drives and control of this mill, as described here, was made by the British Thomson-Houston Company, Ltd., and was commissioned recently. The consulting engineers for the electrical equipment were McLellan and Partners.

THE new five-stand tandem cold reduction mill at the Velindre works of the Steel Company of Wales is designed to roll steel strip to tinplate gauges at speeds up to 5000ft per minute. The stand work rolls are 21in in diameter, 42in long, with back-up rolls 53in in diameter. The tension reel has a diameter of 20in, building up to a maximum of 72in, with a finished coil which may weigh up to 36,000 lb and consist of as much as 6 miles of material.

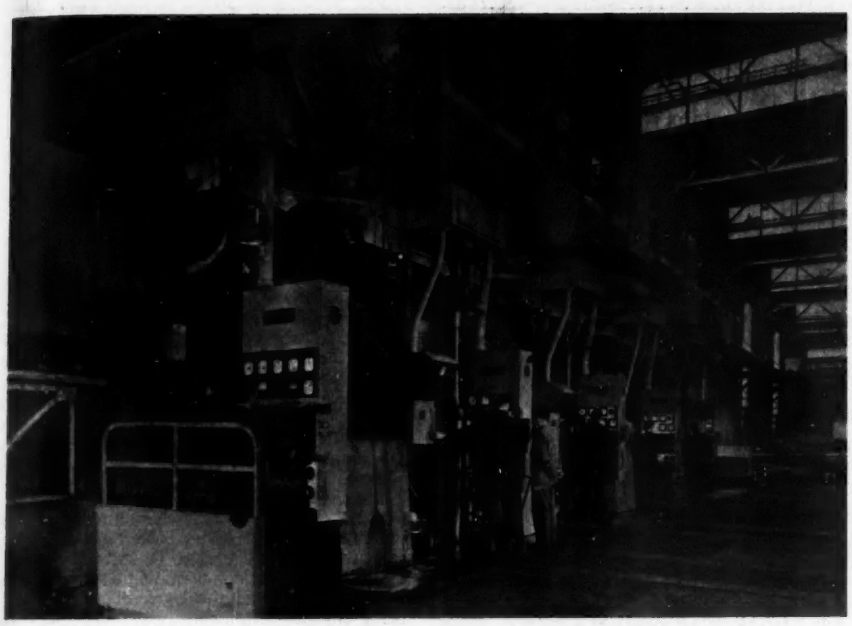


Fig. 1—Five-stand rolling mill at Velindre, showing the control cabinets

The electrical machine circuit arrangement and the stand control scheme are based on an earlier installation at the Steel Company of Wales' Trostre works, with detailed improvements in the equipment and control scheme, such as the reduction in the number of small rotating machines brought about by the introduction of "Magnestats" as amplifying and regulating units, the use of high-speed circuit-breakers and the inherent automatic adjustment of speed droop between running and threading speeds.

Generators grouped in two sets, each driven by a 9000 h.p., 11kV synchronous motor, supply the d.c. motors for the five stands and the tension reel. Each stand motor drives the bottom work roll direct and the top roll through a pinion; the reel motor drives the reel mandrel direct. Regulation of the mill speed is by armature voltage control and the relative stand speeds are adjusted by armature voltage and field control. The motor generator sets, mill motors and exciters and other auxiliary machines are installed in a motor room (Fig. 2) beside the mill, together with the supervisory panel mounting controls and instruments necessary for efficient operation of the drive. In a control room above the motor room are contactor control boards, cubicle-mounted "Magnestats" (magnetic amplifiers), selsyn-operated control rheostats, the alarm indicating cubicle and another supervisory panel controlling synchronous motor excitation. The d.c. line panels for the stand and reel motors, and for the synchronous motor exciters, are installed in the basement next to the motor generator set foundations.

Motor Design

The stand and reel motors are compound-wound machines with offset pole-face compensating windings to give added stability. The load regulation curve of the motors is substantially linear from zero to 1·5 times full load—a characteristic which is important for satisfactory control of mills of this kind. The motors are capable of running at 1·25 times full load for two hours and frequent working peaks of twice full load. To keep accelerating currents and differences in referred inertia between stands as low as possible, armature inertia must be kept down and multi-armature motors are, therefore, used for stands 2 to 5 and the reel, each armature having a greater ratio of core length to core diameter than is usual on conventional d.c. motors. The stand motors have low-inertia drum construction armature spiders, while the reel motor, which has a relatively small armature diameter, has the four armature keys welded directly on to the shaft.

Each mill motor has a tacho-generator and a mechanical overspeed device driven through a special gearbox and coupling from the non-drive end of the mill motor. Speed indicators fed from the tacho-generator are mounted on the mill cabinets and supervisory panel. The speeds and powers of the stand and reel motors are tabulated below.

Speeds and Outputs of Stand and Reel Motors

	No. of armatures	Total h.p.	Output r.p.m.	Mill, f.p.m.
Stand 1	1	1750	90/255	345/1400
Stand 2	2	3500	125/304	480/1670
Stand 3	2	3500	200/445	770/2440
Stand 4	2	4000	350/645	1340/3550
Stand 5	3	5500	500/910	1920/5000
Reel	2	900	233/955	—

Main Machine Arrangement

Each stand motor armature is supplied by a 1600kW, 600V generator. One 731kW, 650V generator supplies the double-armature reel motor. An alternate series connection of generator and motor armatures is used for multi-armature stand motors, giving inherent current-sharing between the machines; in addition, the voltage across any part of the circuit does not exceed that required by one armature even under fault conditions. The individual generator system makes possible a wide speed range on each stand by voltage variation of the stand generator group in addition to the normal

Fig. 2—Motor room at Velindre works, showing (left) motors for stands Nos. 1 to 5, (right) two seven-unit motor-generator sets, and (background) exciter sets

field control range. It also simplifies load compensation adjustment and reduces the fault capacity of the busbar system.

Isolation and Protection

Provision is made for interruption of the motor armature circuits in an emergency by means of high-speed circuit-breakers which are capable of contactor duty on this kind of application and, therefore, make separate line contactors unnecessary. Dynamic braking contactors are used to connect resistances across the motor armatures for emergency stopping.

The circuit-breakers are tripped by either high-set instantaneous overload relays, to deal with sudden severe mechanical overloads, or high-speed relays responding to rate of rise of armature current, to take care of electrical faults. Sustained working overloads are prevented by low-set overload relays with time-delays which, when they trip, bring about a controlled regenerative stop. The operation of an electrical or mechanical overspeed device will also stop the mill by regenerative braking. A controlled regenerative stop will bring the mill to rest as rapidly as possible from any speed, by allowing the maximum permissible regenerative current throughout the stopping period.

With the mill at rest, any stand motor can be isolated by the mill operators by means of the stand selector switch on the stand control cabinet. This operation opens the line circuit-breaker. Complete isolation of any armature is made possible by hand-operated isolating switches in the armature loop circuit.

Synchronous Motor Control

The synchronous motors driving the motor generator sets are designed for reactor starting but they can be started direct on line if necessary. A specially-designed squirrel-cage winding ensures that peak line currents on direct line starting are relatively low. Starting of the motor generator sets can be completely automatic once the line circuit-breaker has been closed. After the motor has synchronised, B.T.H. "Magnestat" control of its excitation maintains either constant power factor or constant reactive kVA.

A 230V d.c. supply is provided by a constant voltage exciter, but a stand-by shop supply can be switched in by a changeover switch.

Mill Speed Control

In Fig. 4 we show a simplified diagram of the mill speed controls. The speed of the whole mill is raised by increasing the voltage of all the generators in unison. Each generator main field consists of two windings, one (*GF*1) supplied by an individual generator field "Magnestat" *GFM*, and the other (*GF*2) supplied by the generator exciter *GE*, common to all generators. The *GE* field voltage is controlled by the master rheostat *MR*. A mill reference voltage, also controlled by the master rheostat, is set up by a master pilot exciter *MP*. The master pilot exciter supplies the reference voltage dials of the stand speed rheostats, so that all stand reference voltages vary with mill reference voltage.

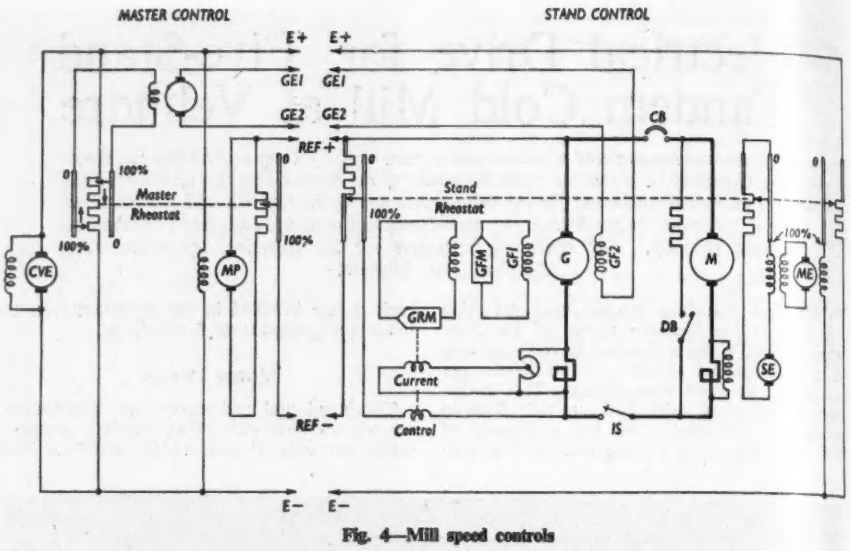


Fig. 4—Mill speed controls

The variable speeds required for rolling duties —thread, high-thread, and run—are preset on small setting rheostats as reference voltages which affect the position of the master rheostat and hence the mill reference voltage.

Control of the mill from the mill cabinets (Fig. 1) is effected by "Thread," "High-Thread," "Run," "Hold," and "Stop" push-buttons. In addition, mill speed can be controlled by "Raise" and "Lower" push-buttons which accelerate or retard the mill at a reduced rate while they are held in.

Stand Control

Individual stand generator voltage is controlled by the generator regulating "Magnestat" *GRM*, which regulates generator voltage to correspond to mill reference voltage as modified by the stand speed rheostat. Any difference between stand generator voltage and the reference voltage causes current to flow in the regulating "Magnestat" (*GRM*) control winding, exciting the generator main field through the field "Magnestat" (*GFM*), to correct the difference. Some voltage difference must exist to maintain excitation, but the amplification of the voltage-regulating loop is such that the generator voltage always corresponds closely to the reference voltage.

Load Compensation.—Motor speed varies with the load current because of armature resistance. Load compensation is, therefore, introduced to maintain the stand speed relationship within definite limits, in spite of varying load, by increasing the stand generator voltage by an amount proportional to motor armature load current. This is achieved by connecting a current control winding on *GRM* to a circuit fed from the voltage drop across the generator compole and compensating winding. The voltage thus introduced into *GRM* current control winding can be varied by means of a load compensation rheostat on the stand control cabinet.

The speed droop due to load is a much greater fraction of actual speed when threading than when running. To keep the ratio of these speeds within acceptable limits, a judicious blending of motor compounding and load compensation is adopted, the degree of compounding being adjusted automatically to have the same effect at all speed settings of the motors.

Reel Control

Constant tension must be maintained in the strip between stand No. 5 and the reel, to build up the finished coil evenly and to keep the gauge uniform. With constant strip speed the reel motor must slow down as the coil diameter increases, the necessary range of speed being obtained by field control which will allow for the increase from the 20in diameter of the reel mandrel to a maximum finished coil diameter of 72in.

The underlying principle of the tension regulating system is that electric power (volts × amperes) is approximately proportional to mechanical power (speed × tension). By making the reel motor voltage proportional to speed and keeping the current constant, tension can be held at a definite value.

Referring to Fig. 3, a voltage proportional to reel motor e.m.f. is compared with the voltage of stand No. 5 tacho-generator *TG*5 which corresponds to strip speed. As the coil builds up, the reel motor slows down and its armature e.m.f. decreases. The resulting difference between the two voltages causes a current to flow in a "Magnestat" *VSM*, the output of which operates the reel rheostat to regulate the supply to the reel motor field. A current winding on *VSM* compensates for any difference between terminal voltage and motor e.m.f. on load. As the "Magnestat" is non-reversing, the reel rheostat can only move in a direction to strengthen the motor field. The position of the rheostat is always a function of coil diameter.

A current regulating "Magnestat" *CRM* compares the voltage drop across a shunt in the armature circuit of the reel motor with a reference

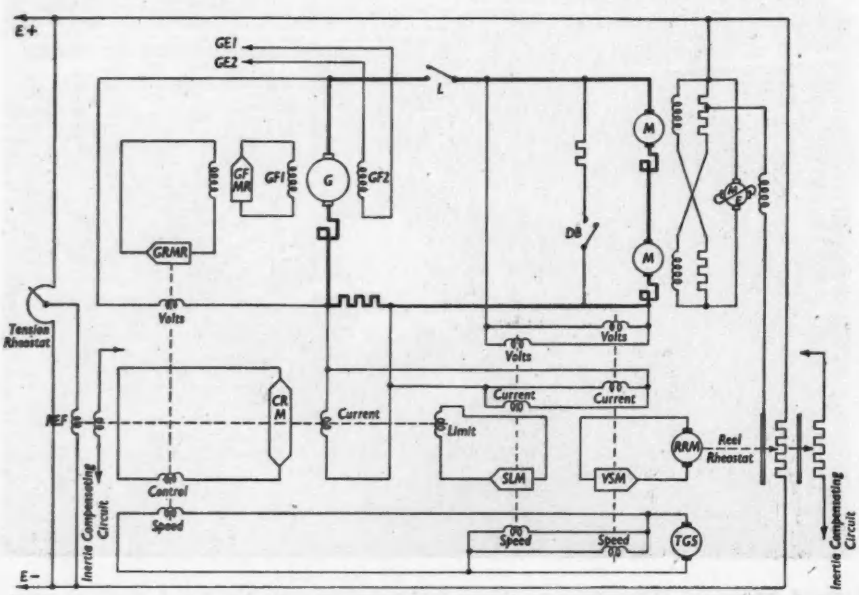


Fig. 3—Tension reel control

set on the tension rheostat while the mill is operating. Any difference in excitation causes a current to flow in the reel generator regulating "Magnestat" *GRMR*, adjusting the generator field, and, therefore, armature voltage, by means of the generator field "Magnestat" *GFMR* to correct the error. When the mill is stationary, the reference excitation for *CRM* is taken from a stalled tension rheostat (not shown). An inertia compensation winding on *CRM* modifies the current reference to maintain tension substantially constant during acceleration and retardation.

If the strip should break, tension would be lost and the motor would accelerate in an attempt to maintain its armature current. A speed limit "Magnestat" *SLM* is excited from the same sources—e.m.f. and speed—as *VSM*. Under normal conditions *SLM* is cut off and *VSM* operates. When the motor accelerates the e.m.f. signal exceeds the speed signal, *VSM* cuts off and *SLM* comes into action, supplying a winding of the current regulating "Magnestat" to hold reel motor speed to safe limits.

Each regulating system is stabilised to prevent hunting and to give the best transient response by the introduction of transformer feedback from suitable points in the circuits into the "Magnestat" fields.

An auxiliary motor generator set and control panel and a mobile control desk are provided in the motor room for barring the main machines round when necessary for commutator and slip-ring turning at any preset speed.

Ventilation

The main machines are cooled by a recirculating air system. A common plenum is maintained in the motor room basement by a make-up air system.

In the case of the motors, air is drawn from the basement by four fans (a fifth being provided as a stand-by), into a chamber in the motor foundations. From there it passes up through air passages formed in the concrete plinth and mezzanine floor to the motors, the relative quantities being adjusted by louvred dampers. Hot air from the motors passes down into the space above the mezzanine floor, from which it is taken by air passages between the machines to coolers, and thence to the basement.

Four fans provide cooling air for the generators, two for each motor generator set, and each fan is capable of feeding either or both. Hot air from the generators is discharged into air passages and back to the common plenum through coolers on the side of the motor generator set foundation blocks.

For the motors and generators the cooling air enters the machines at the drive end and leaves at the commutator end. The commutators are open to the motor room so that access to the brushgear is easy, and commutator dust is prevented from fouling the recirculating air. The small amount of air lost through the commutator seals is replaced by a separate make-up fan and filter supplying clean air to the plenum.

The synchronous motors are self-ventilated by their rotor fans, which draw air from the plenum and return it through individual coolers.

Lubrication

A pressure-regulated flood lubrication system feeds oil to the motor and motor generator set bearings which are ring-oiled. An electrically-driven pump, which can be controlled either from the motor room supervisory panel or by push-buttons in the oil cellar, pumps oil from the storage tank below the motor room through strainers to a double-unit cooler. From the cooler the oil flows along three pipelines, one for each motor generator set and one for the motors, through regulating valves into the bearings. Flow indicating equipment is provided on each bearing. The oil then passes into a drain and through strainers back to the storage tank under gravity. A stand-by pump is provided, the operator choosing which pump is to be used by a switch on the panel. The storage tank is fitted with temperature indicating and alarm equipment.

British Industry and a European Free Trade Area

THE following is the full text of a letter to the president of the Board of Trade from the president of the Federation of British Industries.

You have requested us to inform you urgently of the views held in British industry about a proposal to negotiate with the six Messina countries with a view to joining with them in forming a limited Free Trade Area. As you know, the Federation has been studying the general question of European integration through a special panel which has been working for several months. It has, however, had to work largely in the dark about the intentions of H.M. Government, for it was only at your Press conference on October 3rd that some definition was given to this tentative project by the Chancellor of the Exchequer and yourself. At that stage, we asked for extra time for consideration, and you were able to give us until to-day.

The steps which we have taken have been :

(1) We have held two meetings of our Grand Council, on October 10th and 31st.

(2) Our ten Regional Councils have met.

(3) We have invited the opinions of 287 trade associations in our membership, which between them cover some 20,000 individual firms.

(4) We have given an opportunity to any of our 7400 individual members to express opinions, unless they were satisfied that their views would be covered through one or more of the trade associations.

The Grand Council meeting of October 31st had before it a summary of the results of these inquiries, and has authorised the following presentation of the results.

There has been widespread dissatisfaction with the lack of time to consider these complex issues. Several important trade associations have been quite unable to settle a policy during a single meeting, and have not had time for a second one.

I must emphasise the difficulties there have been from lack of definition. At this early stage so much is unavoidably left undefined (as, for example, the position of dependent overseas territories) that it has been difficult for associations or firms even to say in principle whether they favoured or opposed entry into negotiations, for this would depend so much upon the conditions or safeguards which H.M. Government would require or the concessions which it might make. Entry to a limited Free Trade Area over a period of twelve to fifteen years would be supported or even welcomed by many branches of industry if they were satisfied that safeguards could be negotiated, while it would be strongly opposed if they were not satisfied. Many industries would welcome competition on equal terms, but fear that such terms will not be realised in the event. This has turned out to be one of the most important points emerging from the whole inquiry. We will do what we can later in this report to list the conditions or safeguards most frequently mentioned, but there are others of great importance to particular trades which can best be explained to you by those trades.

Our Grand Council is impressed with the necessity for your department to consult closely with industry throughout the course of any negotiations you may decide to conduct, and wishes the Federation to provide machinery for this if you are willing.

Inquiries from Trade Associations

Of the 287 trade associations in our membership, many have not felt it appropriate to express views on this subject :

Thirteen are district associations covering a variety of manufacturers.

Some forty are concerned with products having no separate export sale, or are otherwise mainly unaffected.

Thirteen are concerned with excluded items in the food, drink and tobacco industries.

Some eighty have combined with a larger kindred association for this purpose, leaving it to the latter to express their views.

The position of the remaining associations is tabulated in Table II.

A real difficulty has arisen as between those who are "in favour, provided" and those who are "opposed, unless" safeguards are assured. This distinction indicates a genuine difference in attitude, for those using the first form of words, while pointing out the need for safeguards, generally favour joining a Free Trade Area, while those using the second form of words feel that it is only with reluctance that they could approve, are sceptical about safeguards, but would agree if satisfied on this point. For this reason, we have listed the "opposed, unless" category under those who are opposed to negotiations, but we have indicated which they are.

It will be no surprise to you to learn that in many cases trade associations have not been unanimous. Both on these grounds, and also because of the widely differing economic importance of the various industries, it would, of course, be quite wrong to express the weight of opinions by merely counting heads.

Inquiries from Individual Members of the Federation

Many firms are not members of any trade association. Others wish for some reason to express an individual view. The Federation therefore gave an opportunity to any of its members to write in if they wished, and it organised a method of analysing the results. Up to October 31st, 525 firms had accepted this invitation, and we tabulate an analysis of their views in Table I.

Table I—*Result of Inquiries from Individual Members*

Five hundred and twenty-five individual firms sent in their views. In a number of cases, these covered more than one of the industry classifications we have used for this purpose. Where this difficulty arose, the views of the firm were recorded under all classifications affected, with appropriate adjustments applied to the numbers of employees. The result is that the summary below records 663 entries. Of these, 479 entries with 610,000 employees favour negotiations ; 147 entries with 75,000 employees are opposed to negotiations; thirty-eight entries with 31,000 employees have found it impossible to form definite views. The analysis is as follows :—

	Favourable		Opposed		No decision	
	Number of firms	Employing	Number of firms	Employing	Number of firms	Employing
Constructional industries and building materials	29	52,450	6	1,900	4	5,400
Metal manufacturers and metal goods	48	97,000	17	10,575	7	3,000
Chemicals	38	30,750	12	2,500	3	800
Engineering Products	170	227,400	36	18,800	12	15,750
Vehicles	33	62,400	6	7,200	1	600
Textiles	56	54,425	29	8,675	6	4,400
Timber and manufacturers of wood	10	9,300	3	975	1	150
Paper and board manufacturers*	7	6,800	12	4,850	—	—
Rubber	9	2,100	1	150	1	50
Other consumer goods	70	60,890	23	18,825	3	600
Miscellaneous	9	4,925	2	75	1	50
Totals	479	608,440	147	74,525	38	30,800

The individual replies follow a very similar pattern to that of the trade associations as regards the safeguards felt to be most important. The need for safeguarding Imperial Preference was mentioned in 20 per cent of the letters received, and the need for anti-dumping legislation, &c., in 15 per cent.

* The "favourable" column here includes wallpaper manufacturers employing 5000.

Inquiries from the Federation's Regional Councils

The ten Regional Councils each consist of some thirty leading industrialists drawn from very varied firms and cover geographically the whole of England, Scotland and Wales. Each has discussed this problem at length, special meetings having been called for that purpose where necessary. With one exception (the North Midlands) the view was formed that the United Kingdom could not afford not to negotiate with a view to reaching acceptable terms for joining a partial Free Trade Area, subject to various conditions. The Regional Councils recognised that the readjustments involved in British industry would be great, but not so great as those which would follow the loss of much of our European markets, or the loss of the benefits of forming a part of a large free market which provided a real opportunity and challenge to British industry. Readjustments spread over twelve to fifteen years would be sufficiently gradual to be surmountable. It must be emphasised that these views are not "representative," but personal to the men concerned.

The Food Industries

Although H.M. Government has announced that a Free Trade Area would exclude raw and manufactured foodstuffs, feeding stuffs, drink and tobacco, some trade associations and firms in these industries have expressed views. The National Farmers' Union, the Incorporated National Association of British and Irish Millers, and the Food Manufacturers' Federation have informed us that they endorse the exclusions. The Cocoa, Chocolate and Confectionery Alliance, on the other hand, feels that each group of products should be considered on its merits; it would regret the automatic exclusion of all its products. The Scotch Whisky Association, The National Association of Soft Drinks Manufacturers and the Cake and Biscuit Alliance would like to see negotiations proceed.

The Problem of Safeguards

The principal points raised are the following:

(1) *Imperial Preference.*—Whatever may be felt about the progressive whittling away of the system of Imperial Preference, few industries would be prepared to see this process accelerated if that can possibly be avoided. It is recognised that the exclusion from the Free Trade Area of food, feeding stuffs, drink and tobacco goes far to protect the interests of Commonwealth countries and so, reciprocally, of our own. But it does appear that the Commonwealth would suffer a partial loss of preferential advantages in comparison with Europe, and if it should be found that this was likely to lead to a weakening

Table II—*Analysis of Replies from Trade Associations*

Product groups	Those supporting negotiations Those marked 1 are "in favour, provided" safeguards are worked out Those marked 2 "do not oppose" further negotiations assuming safeguards are worked out		Those opposed to negotiations Those marked 3 are unconditionally opposed to negotiations Those marked 4 are "opposed, unless" certain safeguards are assured		Those unable to reply Those marked 5 have been unable to reach decisions in the time available Those marked 6 have found opinions too divided to be able to give a collective view	
Metal manufacture and metal goods	1	British Iron and Steel Federation, together with ten conferences concerned with a range of steel products	3	British Ironfounders' Association	5	National Brassfoundry Association
	2	British Steel Founders' Association	3	Sheffield Lighter Trades' Federation	5	Council of Ironfoundry Associations
	1	British Steel Wire Industries' Association	4	British Non-Ferrous Metals Federation, together with ten associations concerned with non-ferrous metal products		
	1	Federation of Wire Rope Manufacturers of Great Britain	3	Woven Wire Manufacturers' Association		
	1	Steel Wool Manufacturers' Association	4	Covered Conductors Association		
	1	Aluminium Industry Council				
	1	Zinc Alloy Diecasters' Association				
	1	Federation of Needle, Fish Hook and Fishing Tackle Makers				
Constructional industries and building materials	1	Export Group for the Constructional Industries	3	British Constructional Steelwork Association	5	Timber Building Manufacturers' Association of Great Britain
	1	Cement Makers' Federation	3	Lead Sheet and Pipe Manufacturers' Federation	6	Federated Quarry Owners of Great Britain
	1	The Chalk Quarrying Association			5	English Joinery Manufacturers' Association
	1	Ballast, Sand and Allied Trades Association				
	1	Metal Windows Association				
	1	Society of British Paint Manufacturers				
	1	National Paint Federation				
	1	Plate Glass Association				
Chemicals	1	Association of British Chemical Manufacturers	3	Federation of Gelatine and Glue Manufacturers		
	1	Association of British Pharmaceutical Industry	4	White Lead and Lead Oxide Convention		
	1	Fertiliser Manufacturers' Association				
	2	Association of Fatty Acid Distillers				
	1	British Plastics Federation				
Engineering products ...	2	Shipbuilding Conference	3	Federation of Surgical Instrument Manufacturers	5	British Engineers' Association
	1	British Electrical and Allied Manufacturers' Association	4	Federation of Associations of Colliery Equipment Manufacturers	5	The Water Tube Boilermakers' Association
	1	British Internal Combustion Engine Manufacturers' Association	4	Cable Makers' Association	6	Radio Industry Council
	1	Agricultural Engineers' Association	4	Radio Communication and Electronic Engineering Association	6	British Radio Equipment Manufacturers' Association
	1	Federation of Manufacturers of Contractors' Plant			5	British Radio Valve Manufacturers' Association
	1	Scientific Instrument Manufacturers' Association			5	Loom Makers' Association
	1	Association of British Manufacturers of Printing Machinery			5	Mechanical Handling Engineers' Association
	2	Food Machinery Association			6	Office Appliance and Business Equipment Trades Association
	2	British Chemical Plant Manufacturers' Association			5	Ball and Roller Bearing Manufacturers' Association
	2	Telecommunication Engineering and Manufacturing Association			5	Association of Crane Makers
	1	British Refrigeration Association				
	1	British Industrial Measuring and Control Apparatus Manufacturers' Association				
	1	Radio and Electronic Component Manufacturers' Federation				
	1	Electric Lamp Manufacturers' Association				
	1	Tank and Industrial Plant Association				
	1	Bobbin Manufacturers' Association				
	1	Steel Works Plant Association				
	1	Hydraulic Association				
Rubber	1	Federation of British Rubber and Allied Manufacturers' Associations			5	Tyre Manufacturers' Conference
Vehicles	2	Society of Motor Manufacturers and Traders	3	Locomotive and Allied Manufacturers' Association of Great Britain	6	British Cycle and Motor Cycle Industries Association
	1	Society of British Aircraft Constructors				
	2	Railway Carriage and Wagon Builders' Association				
Textiles	1	Wool Textile Delegation	3	British Jute Trade Federal Council	5	Federation of Master Cotton Spinners' Associations
	1	Export Group, National Wool Textile Executive	4	Silk and Rayon Users' Association	5	Condenser and Allied Spinners' and Manufacturers' Association
	1	The National Association of Scottish Woollen Manufacturers	3	Federation of Lace and Embroidery Employers' Associations	5	Flaxspinners' and Manufacturers' Association of Great Britain
	1	Textile Finishing Trades Association; Confederation of Textile Dyers and Finishers	4	Pressed Felt Manufacturers' Association	6	Furnishing Fabric Federation*
	2	Cotton Spinners' and Manufacturers' Association	3	British Mat and Matting Manufacturers' Association	6	British Paper Machine Felt Association
	1	The Federation of Calico Printers			6	Lancashire Mechanical Cloth Manufacturers' Association
	2	Bleaching Trade Advisory Board			5	Central Council of the Irish Linen Industry
	1	National Hosiery Manufacturers' Federation			5	Federation of British Carpet Manufacturers
	1	Hawick Hosiery Manufacturers' Association			5	Webbing Manufacturers' Association
	2	British Man-Made Fibres Federation				
	2	Rayon Weaving Association				
	2	Master Packers' Association				
Paper and board and paper products	1	The Federation of Master Printers	3	British Paper and Board Makers' Association		
Timber and manufacturers of wood	1	Federated Home Timber Associations	3	Association of British Wood Wool Manufacturers		
	1	British Furniture Manufacturers' Federated Associations	3	Timber Trade Federation of the United Kingdom		
Other consumers' goods ...	2	Wholesale Clothing Manufacturers' Federation of Great Britain	4	United Tanners' Federation	6	Glass Manufacturers' Federation
	2	British Leather Federation	3	British Pottery Manufacturers' Federation	5	Metallic Slide Fastener Association
	1	Federation of Leather Belting Manufacturers of the United Kingdom	3	Oilskin Manufacturers' Association of Great Britain	6	British Jewellers' Association
	1	Drawing Office Material Manufacturers' and Dealers' Association	3	Surgical Dressings Manufacturers' Association	5	Federated Associations of Boot and Shoe Manufacturers
	1	British Comb Makers' Association	3	Medical and Surgical Plastermakers' Conference	6	Linoleum Manufacturers' Association
	1	Federation of British Manufacturers of Sports and Games				
Miscellaneous	1	Hard Fibre Cordage Federation			5	Federation of Soft Fibre Associations
	1	The China Clay Association			6	National Federation of Clay Industries
	1	British Ball Clay Producers' Federation			5	British China Clay Producers' Federation

* Different sections of this trade take opposing views.

of reciprocal preferences accorded to the United Kingdom, many industries would regard this as a very grave objection to entering a Free Trade Area. Certain industries foresee a specialised problem of importance. They fear that when tariffs between members of the Free Trade Area are progressively reduced, the U.K. preferential rates which are exceptionally applied in respect of their products as regards imports from Commonwealth countries would have to come down with them. If that were so, one result would be a widening of the preferences as between Commonwealth countries and countries outside the Free Trade Area, which is contrary to the G.A.T.T. rules. This might well result in standard U.K. rates of tariffs on those goods being reduced. Any such developments would, of course, be of the utmost seriousness, and would be likely to turn those few industries which would be affected by this point into positive opposition to association with a Free Trade Area.

(2) *Dumping and Unfair Trade Practices.*—Tight rules governing these matters, and especially dumping, would be essential, not only during the 12–15 years formative period but afterwards. It is sometimes held that dumping cannot exist within a Free Trade Area, on the grounds that dumped goods can be sold back to the country of origin ; but costs of transport may prevent this and also experience shows that in some countries goods may be dumped which have no market in the country of origin. In any case, dumping can occur from third countries. Strong anti-dumping legislation is, therefore, required, and it is felt that this might have to go further than was foreseen when the G.A.T.T. rules were drawn up. Among other unfair practices which must be dealt with are subsidies, whether overt or hidden.

(3) *Other Discriminations.*—All barriers other than tariffs which either interfere with the free movement of goods or are discriminatory in effect should receive special scrutiny, including quotas, specification or registration regulations and anomalies in patent and trade mark protection. A clear understanding should be established as to the percentage of value of local manufacture to be required before a product can qualify as an export of the country concerned. The actual figure may well be different for different products.

The coal industry clearly raises some very special problems.

(4) *Exchange and Currency Problems.*—It appears to many people in industry to be essential to provide safeguards to prevent the use of currency manipulation by members of a Free Trade Area as a means of protection or discrimination between one another. It is considered essential to provide for the greatest possible liberalisation of payments and capital movements.

(5) *Taxation.*—It must be made possible for U.K. industry to compete on equal terms. In these days when re-equipment and modernisation of plant depends so largely upon ploughing back of profit, the effect of very high taxation has to be compensated by the level of gross profits. Competitive conditions in a Free Trade Area may, therefore, lead to a progressive decline unless taxation is reduced. British industry must be no worse placed in this respect than its competitors. It is also necessary that permitted rates of depreciation on plant should be no less favourable for British industry.

(6) *Labour Costs.*—Labour costs—including rates of pay, hours of work, paid holidays, and the cost of social security and other welfare services—are felt to be lower to an important extent in some of the Messina countries than in the United Kingdom. Unless during the formative period greater harmonisation occurs, the competitive position of U.K. industries would be severely endangered.

(7) *Export Agreements.*—Export agreements made by British manufacturers must not be treated legislatively less favourably than similar arrangements made by the nationals of any country which is a member of the Common Market.

(8) *Strategic Industries.*—Certain industries have been set up in the United Kingdom under protective duties and other measures for purely strategic purposes, and some would be most unlikely to survive if all protection were withdrawn. Their case is of special difficulty, and appears to require particular treatment.

Principal Objections Raised by Those in Opposition

Those industries which are strongly opposed to negotiations put forward the following principal reasons for their view :

(1) They fear the flooding of their home market with no compensating advantages in freer entry to the European markets.

(2) They consider that other European countries enjoy natural advantages which cannot be overtaken by improvements in efficiency. This is particularly true where another country has domestic supplies of raw materials not available in the United Kingdom, e.g. wood pulp.

(3) They are deeply sceptical of the possibility in practice of working out watertight safeguards which would enable competition to be conducted on level terms.

I trust that this report will be of use to H.M. Government. We recognise that what is being decided now is merely a first step. In the event of the proposal being pursued, it is in our view essential that machinery be established at an early date not only for continuing consultation with us upon the general problems, but also with individual industries upon their own special difficulties.

Concrete Runway and Road Construction

RECENT trends in the construction of concrete roads and airfield runways were discussed recently at the annual meeting of the Cement and Concrete Association's Pavings Development Group. The Group held its technical sessions at the Victoria Halls, Bloomsbury Square, on October 17th, when two papers were presented, namely, "Concrete Runways," by Mr. F. R. Martin (who is superintending civil engineer for pavement design of the experimental and development branch of the Air Ministry's directorate-general of works), and "Concrete Road Construction To-day," by Mr. D. R. Sharp, of the Cement and Concrete Association. A lecture was also given by a Danish highway engineer, Mr. J. Hoffman, on "Concrete Road Construction in Denmark."

Mr. Sharp's paper aimed at an objective survey of concrete road construction, concentrating on aspects where the choice of technique was obscure through lack of knowledge or because available evidence was conflicting. Mr. Martin discussed new techniques in building airfield runways. This topic is of special interest since much of recent work is subject to security considerations and so cannot be described, even though runway construction is a highly mechanised and not unimportant part of the civil engineer's achievements. The remainder of this article is an abstract from Mr. Martin's paper.*

Riding Quality

Concrete and good riding quality are only rarely associated either by the motorist or the aircraft pilot because—let it be admitted—many acres of both road and airfield pavements have been constructed over the years without sufficient thought being given to the comfort of the user. To-day, however, emphasis is being placed on surface tolerances that must be achieved to give a good ride, the most essential characteristic of a pavement. Tolerances of $\frac{1}{4}$in variation in 10ft with q values of 30in per mile are the desirable limits that are being called for by aircraft with tyres whose pressures are so high that they are virtually solid and whose undercarriage arrangements need an even surface on which to land and take off.

How is such precision of surface finish being obtained ? Eight different airfield jobs at present under construction in this country showed different machine arrangements adopted by each contractor ; the common denominator was a scraping straight-edge. This item alone has done more to give good riding quality to concrete pavements than any other single piece of equipment. The use of such a tool was introduced, after seeing its effect on pavements in the U.S.A., by persuasion rather than dictation, for it is the Air Ministry policy not to specify rigidly the manner in which a contractor will do his job, but rather to suggest one method, if it is thought to be a good one, leaving scope for alternative suggestions. The importance of the scraping straight-edge can be judged from the fact that it has been adopted by all contractors and they are finding that tolerances of $\frac{1}{4}$in in 10ft are now quite possible.

It is a simple tool, being merely a 10ft straight-edge mounted on a long handle, but having sufficient weight and rigidity to act as a cutting and smoothing tool while still maintaining its shape. For proper operation the straight-edge is placed on the pavement at the near edge, and with the handle at knee height is pushed across the surface to the far edge. The handle is then lifted to shoulder height and is pulled in the same path to the near edge. After this operation is completed the straight-edge is moved half its length and the process repeated. When introduced, as in some cases, at more than one point in the train of laying equipment, the final surface of the hardened concrete can hardly fail to have the specified surface tolerance. To be able to use the straight-edge properly the concrete must be fairly workable. There has therefore been a breakaway from the use of the stiff, lean, harsh mixes that gave all the strength in the cube but so often left honeycombing in the pavement slab and resisted a satisfactory surface finish. Let us see no more of the eight and nine to one aggregate/cement ratio mixes of nil slump. Let us rather use mixes of about six to one aggregate/cement ratio by weight and keep the water/cement ratio at about 0·50 and have mixtures sufficiently plastic to give concrete handlers a chance to place them correctly to level.

Joints

But what of the problem of forming the joints ? These, too, need no longer interfere with smooth riding, for after a joint has been formed in the plastic concrete it can be filled right to the surface with a filler board and the scraping straight-edge used to even out the surface right across it. The top few inches of the filler board can later be cut out to a depth of a few inches for sealing. With this method there is no need to bullnose the joint edges of any but expansion joints, which require to be sealed below the surface, or to disturb the concrete in any way after the straight-edge has done its job. Perhaps, too, a ban could be placed on the use of small trowels.

Of course, there is always the alternative of sawing "dummy" joints in the hardened concrete and so avoiding any disturbance of the plastic concrete. Where limestone aggregate is used this alternative is generally economical and is now almost invariably used. With igneous rock aggregate and even more so with flint-gravel aggregate, it is less likely that joint cutting, even if successfully carried out without producing a jagged edged joint, will be an economic proposition. Whatever the aggregate, all saw cuts should be made with special saws, using one or more circular diamond or silicon-carbide blades. These should be powered by engines with at least 25 b.h.p., and should be cooled during cutting with an abundant supply of cold water. This water flowing about the site can be quite a nuisance.

Effort, too, must be made to cut the joints before any random cracking of the concrete occurs. It is difficult to judge the right time to cut with any but limestone aggregate concrete, which, of course, is not so sensitive to temperature

* The paper "Concrete Runways" is Crown copyright reserved.

changes as is gravel aggregate concrete. It may be at any time between about eight hours and three days after laying. Random cracking will probably always occur to a certain extent, but it may be that a certain number of cracks can be accepted, providing they are not too numerous. This outlook appears to be the one held in the U.S.A., where joint sawing is adopted much more as a matter of course than it is in this country.

For the sealing of joints two compounds have been used extensively : bitumen/rubber materials for areas of pavements not subjected to jet fuel spillage, and pitch/rubber materials for areas which are subjected to spillage. None of the materials so far developed is 100 per cent resistant to jet heat and blast attack. This problem has been overcome to a certain extent by finishing the seal below the top of the pavement.

One promising method of joint sealing with plastic strips has recently been investigated and trial areas have been laid to check the efficiency of the seal provided under cold weather conditions. For this method to be successful a very uniformly cross-sectioned joint sealing space is needed.

Design

There was no standard train of equipment used on each of the eight airfields, but each contractor has chosen what he thinks is necessary to achieve the specified standard of finish and the strength of concrete in the final pavement.

As far as strength of pavement is concerned, sufficient experience exists to enable the design of a concrete pavement to be undertaken with confidence that it will not break up under present or future known aircraft traffic. Design curves relate flexural strength, load (expressed in terms of load classification number), sub-grade support, and pavement thickness. Two scales of concrete flexural strength are introduced, one for normal pavements where the anticipated repeated traffic is not expected to exceed 10,000 loads, and one for " channelised " traffic where up to 40,000 repeated loads are expected. For instance, one scale might be used for the longitudinal middle section of runways while the other might be used for the centre lanes of taxiways. The scales have been adjusted by introducing the idea of concrete fatigue under repeated loads allied to increasing flexural strength with age.

Specifications now call for a minimum flexural strength of cast test beams instead of a minimum compressive strength of test cubes to measure the quality of pavement concrete. Test cubes, 6in in size and tested at seven and twenty-eight days, have for so long been the measures of concrete quality and uniformity, and yet designs have generally been based on flexural strength. The logical measure of beam strengths has now been introduced. Although beams sized according to British Standards will be specified, about a dozen sites have already been equipped with a novel beam testing machine which is of American manufacture and tests beams over a span of 18in. The machine is portable and allows the easy testing of beams, the strengths of which are recorded automatically on a simple chart. What better record of concrete quality could a resident engineer wish for than a folder of these charts ? This raises the query as to why the British Standard and the A.S.T.M. beams differ in size, and where is the equivalent machine of British manufacture ? The information already obtained, using the American machine, is not yet very extensive.

Flexural Strength and Load Carrying Capacity of Concrete Pavements

The effect of flexural strength on the load-carrying capacity of a normal 8in unreinforced concrete pavement has been investigated in a full-scale experiment by measuring the load needed to cause corner cracking of a number of 8in slabs laid on a uniform base of Westergaard " k " (modulus of sub-grade reaction) of about 300 lb per square inch per inch. The slabs were made with four aggregate combinations, i.e. flint gravel with sand fines, crushed limestone with sand fines, crushed limestone with limestone fines, and crushed granite with sand fines. For each combination four types of mix were used, giving a strong dry mix, a strong wet mix, a weaker dry mix and a weaker wet mix. There were, therefore, sixteen different mixes which were laid at random to give two 20ft square bays per mix and so allow eight free corners for testing.

The concrete was laid in June, 1955, and tested twelve months later by applying loads through an 18in diameter plate until a crack was formed at each corner. From each bay, one broken corner was removed completely and was sawn into standard sized beams which were tested for modulus of rupture and " modified " cube strength. Beneath each corner removed, " k " tests were also taken to check the uniformity of base support. It would seem that although any one of the usual sample strengths gave a good guide to the actual pavement strength, the best guide was the flexural strength of the beam sawn from the pavement and tested at about the same age as the pavement itself.

Prestressed Concrete

Perhaps the most interesting development in concrete airfield pavement work in the past twelve months has been the laying of an experimental jointless prestressed concrete platform some 200ft square.

It has generally been agreed that to attempt to stress a concrete slab while it is in contact with the ground results in a large amount of the stress being lost in the centre of the slab due to the friction set up between the slab and the ground during the process of stressing. In this new scheme, the basic idea is that the concrete is stressed while it is off the ground. To enable this to be done, the pavement was built up of precast panels, 6in thick, which were lifted by vacuum suction pads on to small dwarf walls projecting about ¼in above a prepared base. The stressing wires were then threaded through ducts which had been formed at 3ft centres in both directions during the casting of slabs and the required amount of stress was put into them by jacking. Special panels were built to accommodate the extra stress at the edges. During stressing the panels were able to move on the walls to ensure an even distribution of stress throughout the whole pavement area. After stressing, both the cable ducts and the space beneath the slabs were grouted with a colloidal grout pumped in under pressure.

The pavement has only recently been completed and has not yet been load tested but, with an induced stress of some 250 lb per square inch and a concrete flexural strength of some 600 lb to 800 lb per square inch, it is expected that the pavement will be able to support virtually an unlimited number of applications of loads of at least 50,000 lb on a 12in diameter plate.

To ensure high early strength it was decided to use the vacuum process to remove excess water from the concrete which, due to the thin slab section and the duct formers in two directions, needed to have a high workability for easy placing. The important slab dimension was, of course, its depth. It was, therefore, somewhat disappointing to find that the vacuum process resulted in variations in slab thickness from slab to slab. These were caused to some extent by the variable amounts of water sucked out from the slabs and also to the pad movement on the surface at the time of the suction release. To overcome this difficulty, it will be necessary either to dispense with the vacuum process altogether or to cast the slabs vertically.

The main objects of the experiment were first to see whether an idea so revolutionary as stressing a slab while off the ground could be used in practice and, secondly, whether the pavement as constructed would be as strong as calculated and would maintain its strength at all times of the year. Time has so far only allowed the first object to be proved.

The economics of such construction are difficult to assess from the relatively small experimental slab, but it is expected that, for heavy duty pavements, the relatively high cost of the process of manufacture and stressing will be off-set to a large extent by the savings in excavation work, in joints, and in material quantities. It is unlikely, however, that such a type of construction will be economical for road work but for very heavy duty pavements it may well be the only successful answer.

Research in Loose-Boundary Hydraulics

LAST week, the Press was invited, for the first time, to the Hydraulics Research Station of the D.S.I.R. at Wallingford, near Oxford. The establishment at Wallingford is a new one ; it has been brought into use, gradually, since 1952 and work on hydraulic models has been transferred to it from the National Physical Laboratory. At present the main hall, which is a large building laid out for the special needs of model studies, is in full use with a number of researches in various stages of completion. Apart from the main hall, there are various other facilities, including outdoor sites for large models, and open channel investigations, wave tanks, a workshop and instruments section, and so on.

It was pointed out by the director of the station, Sir Claude Inglis, that although much pioneering work in the subject was carried out in this country by Osborne Reynolds, Vernon Harcourt and Professor Gibson, for example, until recently there had been no continuity. By contrast, first Germany, and later India, Holland, France and the U.S.A., developed large research stations during the past thirty years. Sir Claude considered that the work at Wallingford was still on quite an inadequate scale, and more investigations had to be refused than were accepted ; but the station, as far as it went, was a model of what was required for such work. Important fundamental research was planned, but solving practical problems affecting industry abroad was considered of even greater importance. Sir Claude emphasised that models of rivers and coasts with fluctuating conditions, though they gave essential data about currents and tides which could not be obtained satisfactorily in any other way, were merely an important aid and not the solution to complex hydraulic problems.

Much work of interest was to be seen at the station, in basic and applied research and in other activities, such as the development of the special apparatus and measuring instruments—wave makers, tide generators, flow and current meters, wave measuring devices, and bed plotting apparatus—needed for model work. Some examples of this part of the station's work have already been described in these columns. In the following notes, therefore, we give in outline the achievements on one or two of the studies selected from those now in progress at the station.

Tema Harbour Model.—A new harbour is now under construction at Tema, some 20 miles east of Accra, in the Gold Coast. It has been designed by a British consulting firm, which submitted its design to the station for testing in a model. The model reproduces a stretch of coast 13,000ft long and extends the equivalent of about 7000ft out to sea. Accuracy in the reproduction of the bed is particularly important in wave disturbance models, and in the Tema model levelling is thought to be accurate to within $\pm^{1}/_{16}$in, while accuracy in plan is to within $\pm\frac{1}{4}$in. The basin in which the model has been built can produce storm waves coming from any of the directions known in nature. The wave generator can produce waves of any required height and of the equivalent of any period between seven and forty-five seconds. The effectiveness of the harbour in protecting ships against storm waves was determined by comparing the heights of waves outside and inside the harbour, wave heights being recorded automatically with elec-

trical resistance gauges. For waves longer than storm waves, a surge generator is used, capable of generating waves of any period between forty seconds and five minutes. Such waves in nature are usually very low, seldom more than a few inches in height, and they cannot be detected by eye. Nevertheless, they can cause quite large horizontal movement of ships.

The first stage of the investigation was concerned with the entrance of the main harbour. The station was able to show that the outer breakwater could be 500ft shorter than proposed without impairing the efficiency of the harbour. The cost of the breakwater at this point is between £200 and £300 per foot. In the second stage of the investigation nine different designs of the entrance to the small fishing harbour were examined. The design that was finally accepted had many advantages compared with that originally proposed, but as the entrance is to be situated at a depth where the waves break it is considered impossible to design an entirely satisfactory entrance for that position.

Navet Dam Spillway.—The Navet River, which rises in the Central Range in Trinidad and flows into the Nariva Swamp on the eastern seaboard, is to be dammed at a point about 4 miles below its source. The reservoir so formed will provide a water supply for the surrounding area. The consultants responsible for the design of the spillway submitted it to the station to be investigated. The design involved a departure from standard practice. The proposed spillway consisted of a 200ft weir, which discharged water down a sloping channel to a stilling basin. From this stilling basin the water flowed over a second weir to a second stilling basin and then to an earthen flood channel leading back to the old river channel. The principal points of interest in the spillway design were :—(i) The sloping channel below the 200ft weir had a stepped bed and converging sides ; (ii) the upstream stilling basin was curved and turned through an angle of 43 deg.; (iii) the downstream stilling basin delivered the flow to an erodible earthen flood channel.

In the model, part of the reservoir was reproduced so that the approach conditions to the 200ft weir would be correctly simulated. At the downstream end of the model the first 300ft of the flood channel was moulded in sand in order to study bed and side erosion. Three changes to the design were suggested as the result of an examination of the design and model tests. First, it was shown that the proposed depth of the upstream stilling basin was insufficient to cause "stilling" for the higher range of discharges. The bed level of the basin was, therefore, lowered by the equivalent of 3ft. This proved to be effective and the hydraulic jump was formed in its correct position at the upstream end of the basin. Secondly, a large eddy which formed in the curved stilling basin was eliminated by placing comparatively small deflector walls in the fast flowing water near the foot of the stepped channel. Thirdly, information was obtained concerning the design of the lower fall and the protection of the erodible bed of the flood channel, which made it possible to predict the level to which the bed of the flood channel would erode and the original design was modified to suit these conditions. A model test indicated that if this modification was incorporated bed material would tend to build up against the downstream end of the structure, thus ensuring its safety. Essential data for the model were : scales, linear, 1/24 ; velocity, 1/4·9 ; discharge, 1/2824 ; total fall (reservoir to flood channel), 53ft; flood discharge, 6100 cusecs.

Shrewsbury Flood Relief Scheme.—The River Severn starts to flood the town of Shrewsbury whenever its flow exceeds 10,600 cusecs. In recent years, flooding has occurred on the average once a year and there have been two serious floods. In February, 1946, during the highest flood since 1795, the estimated peak discharge was 18,000 cusecs, and this resulted in a water level some 6ft higher than the bank level. Severe flooding, causing damage to property and dislocation of traffic and communications, was again experienced in March, 1947, when the flood peak rose to a level only 5in lower than that recorded the previous year. A flood relief scheme was prepared in 1948 by the engineer of the Severn River Board. The scheme included cleaning up the river channel from a point immediately upstream of Shrewsbury for a distance of about 9 miles downstream and removing an existing solid weir and replacing it by a battery of three semi-automatic sluice gates with small fixed side weirs. The total cost of the scheme was estimated at about £1,000,000.

A model study of this scheme was made with the following objects:—(*a*) to check the estimated reduction of flood levels in Shrewsbury, (*b*) to investigate the effects of the scheme on the unimproved river downstream, and (*c*) to ascertain whether the proposed scheme might be modified to reduce its cost without impairing its efficiency. Two models were constructed for the investigation—a large-scale model of the 4-mile stretch of the River Severn around Shrewsbury, mainly for objectives (*a*) and (*c*), and a smaller scale model reproducing about 24 miles of the river from Shelton, 3 miles above Shrewsbury, as far downstream as Buildwas at the head of the Ironbridge Gorge. This has been used for objectives (*b*) and (*c*).

Water levels in the smaller model (horizontal scale, 1/200, vertical scale 1/50) were measured by micrometer point gauges (reading to 0·001ft), mounted at points on the model corresponding to the positions of measuring points on the river. Discharges were measured on a free-running rotary flowmeter. The first stage in the investigation was to prove the model, i.e. to verify that water levels observed in the river for different flows were correctly reproduced. Then the proposed improvements were incorporated into the model and the lowering of water level at each gauging station over a wide range of flows was determined. The following conclusions were drawn :—(1) The improvements envisaged in the scheme would reduce flood levels in Shrewsbury by about 2ft. (2) Very nearly the same results would be gained if only 3 miles of the river immediately upstream of Shrewsbury Weir were improved. This would reduce the cost of the scheme. (3) The improvements would have little or no adverse effect on river levels downstream of the improved section. (4) It would be possible to use an existing dry channel, which was probably once a course of the river, as a by-pass channel. (This is now known to be impracticable due to building development in the area.)

Basic Coastal Model.—The basic coastal model is used to investigate why some beaches erode and why sand builds up on others, and also to assess the value of different coastal defence structures. In this model all conditions are under control and alternative sea defence works can be compared under identical conditions.

The model beach is built to a horizontal scale of 1 in 30 and a vertical scale of 1 in 20. It is an idealisation of the beach at Dunwich in Suffolk. Extraneous ridges and troughs have been smoothed out, and all the contours are straight and parallel. A length of beach 3000ft long is represented, extending 1400ft seawards.

The tides and tidal currents that are reproduced in the model are scaled down from those appropriate to Dunwich. The wave height is the equivalent of about 2½ft and the wave periods six and a half seconds. These wave characteristics were not obtained directly from the site but were found by trial and error from experiments in which the object was to mould a beach of the Dunwich profile by wave action. The waves can be said to be equivalent to all the many waves reaching the Dunwich beach during a year with a bias towards the waves that had been working at it at the time immediately preceding the survey. The direction from which waves come has been arbitrarily fixed at 30 deg. to the left of normal for the present set of experiments. The beach represents, therefore, one in which there is a steady drift of sand always in the same direction, one that reacts most readily to a system of groynes.

The model has recently been used to investigate the influence of a permeable screen consisting of spaced piles set parallel to the beach. The model showed it to have a small beneficial effect if the screen was erected at a point on the beach between high and low water. The deposit of sand was, however, small compared with the deposit found in the upstream compartments of an orthodox groyning system. The first system of groynes that was investigated reduced the rate at which volumes of sand travelled down the beach to a quarter of the normal rate. The measurement of this reduction is one of the main objects of the experiment because it is a necessary figure in the calculation of the manner in which a new groyning system fills. The behaviour of different kinds of orthodox groynes is now being investigated.

The Mersey Estuary.—An investigation of two major problems in the Mersey is being carried out for the Mersey Docks and Harbour Board. An adequate depth of water is maintained in the Narrows and the approach channels to Liverpool by the large volume of water which flows into and out of the Upper Estuary as a result of the flow and ebb of the tide. Since 1861 the volume of this flow has dropped by 8 per cent due to a decrease of that amount in the capacity of the estuary. Although the general trend has been one of deterioration there have also been periods of increasing capacity. It is necessary, therefore, to determine what factors control the capacity to forecast future trends and to estimate what effect these will have on the approach channels to the Port of Liverpool.

The second problem is concerned with the rapid silting which is taking place on Bromborough Bar in the approach channel of the Manchester Ship Canal and the Queen Elizabeth II oil dock. With the construction of the oil dock it was necessary to cater for tankers having an arrival draught of 34ft, by providing a channel 5ft deeper than that required previously. Early in 1953, however, conditions at Bromborough Bar showed signs of deterioration, the rate of accretion being abnormally high. Deepening was started in July, 1953, and up to December, 1955, 4,000,000 cubic yards of material were dredged from this area, but a net increase in mean depth of only 2ft was achieved. The aim is to find the source of this material, perhaps by using radioactive tracers, and, if possible, to suggest means of preventing it being deposited, or to find out whether the source of supply will be exhausted if dredging is continued.

Two models will be built to study these problems, one of the upper estuary upstream of Rock Light, to a horizontal scale of 1/550 and a vertical scale of 1/60, and a smaller model, probably with a horizontal scale of 1/2000 of Liverpool Bay and the Upper Estuary. The first of them is under construction, and will have the weir type of tide generator recently developed at the station. A special survey team, with a temporary laboratory in the offices of the Mersey Docks and Harbour Board, has been set up to collect and analyse information about the river.

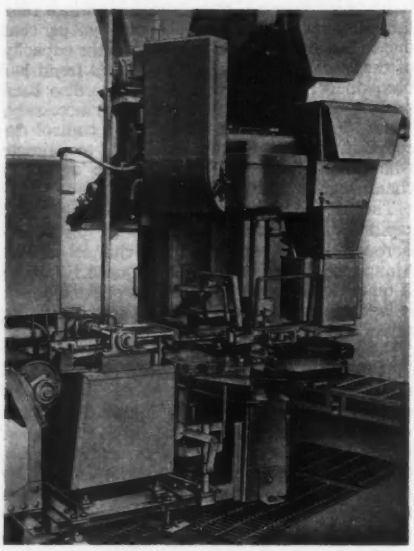
Books of Reference

Textile Machinery Index. John Worrall, Ltd., Central Works, Oldham. Price £2 2s.—This new book of reference provides a comprehensive catalogue of the firms manufacturing textile machinery and the wide range of accessories and ancillary plant used in the textile industry. The main part of the book is divided into sections, each devoted to the makers specialising in the machinery and other equipment used in one branch of the industry. In most cases there are also listed under the firm's name general particulars of the particular types of machines made, the manufacturing facilities at the firm's works, its agents and the principal members of the executive and sales staffs. Users of the book are further assisted by comprehensive buyers' guides in which the machinery and equipment headings are supplemented by translations in German, French and Spanish to assist overseas buyers. To facilitate rapid reference the book is thumb-cut and the sections are printed on contrasting colours of paper.

Directory of Members, 1956. Reinforced Concrete Association, 94/98, Petty France, London, S.W.1. Free on application.—The Reinforced Concrete Association has two classes of membership, viz. ordinary members, which are corporate bodies in professions and businesses which are concerned in some way with reinforced concrete, and associates who are persons interested in furthering the study of that subject. The objects of the Association are explained and its membership is listed in this book. The list of members is classified under the various branches of reinforced concrete work in which they specialise.

Automatic Moulding Equipment

THE first "Hallsworth" automatic moulding installation has been placed in service at the Walsall works of Platt Malleable Castings, Ltd. This plant was built by Rubery Owen and Co., Ltd., and it incorporates all the equipment required for a completely mechanised foundry using vertically poured 12in by 9in by 5in boxes for the production of small to medium repetitive castings in all known foundry alloys. It consists essentially of a sand preparation plant feeding an automatic moulding machine, from which the boxes are deposited on a roller conveyor at the



Loading side of four-station indexing automatic moulding machine. The sand filling station can be seen on the right, the squeezing station at the rear, and the take-off station on the left

end of which they are closed and set on a rotating conveyor with a pouring station. At the end of a preset cooling period on this rotating conveyor the moulds are knocked out and the boxes placed on a return conveyor to the moulding machine, whilst the sand is returned by an underground belt to the reconditioning plant for re-use.

The new plant can be seen in the photographs we reproduce on this page, one of which shows the "Hallsworth" four-station, self-indexing, automatic moulding machine. This machine performs the operations of spraying, sand metering, edge tucking, strickling, squeezing and stripping, and deposits the moulds on to a conveyor ready for coring and closing. It is stated to be capable of producing up to 240 completed moulds an hour. The table indexing mechanism of the machine serves as the master control for the plant cycle and its rotation is effected by a pneumatic cylinder, the operation of which is controlled by a master hydraulic cylinder. A needle valve serving the hydraulic cylinder is used to control the cycle time of the machine. The table is turned by a pawl and pawl wheel and a hydraulic shock absorber is fitted to prevent undue shock on the table lock. Grooved cam plates on the pawl and pawl wheel actuate the rocker arms of pilot valves controlling the other operations of the machine. The table automatically carries the half box and pattern of the mould through the four stations of the machine.

In the cycle of operations the box part and the pattern plate are positioned on the table at the first station and the operator then pulls a hinged sand allowance frame on to the box. As the box part is then indexed to the second station to receive sand it is sprayed with parting fluid. The sand is discharged from a rotating hopper which turns through 180 deg., and a frame fitted round the sand chute then descends and compresses the sand round the edge of the mould. At the third station the main squeezing operation is performed : at the fourth station the pattern plate is vibrated and the half mould removed by take-off arms which place it face upwards on the coring conveyor. Four hinged frames are fitted on the table driving shaft at the rear of the box stations, and these frames are so sprung that they can occupy either a vertical or a horizontal position. Their purpose is to contain surplus sand for ramming requirements and to prevent spillage. The frames are set vertically during loading and unloading of the box parts and horizontally during edge tucking and squeezing. When a new moulding box is placed in position the operator lowers the frame, and it is held down horizontally on the box by the overcentered spring. Between the third, squeezing, station and the fourth, mould ejection, station a projection at the back of the frame passes under a trip wheel, which forces it into its vertical position clear of the box.

Sand is fed to the filling station through a steel chute, at the top of which is a rotating double-sided hopper with two opposed compartments. One of the hoppers is always in an upright position to receive sand from a conveyor. The hopper is rotatable through 180 deg. by a double-acting pneumatic cylinder to deposit sand from the upper compartment into the chute. The amount of sand fed into the compartments between indexing operations is preset by a gate which controls the height of the sand on the belt. A flanged frame round the sides of the chute, which is used for "edge-tucking" after filling the box, is actuated by two double-acting pneumatic cylinders.

Mould stripping is effected through four pins in each wear plate of the table, the pins being located on the corners of the box and raised by a hydraulic cylinder. The mould take-off and scraper equipment can be seen on the left-hand side of the machine in our illustration. It consists of two steel lifting arms actuated by gearing by a pneumatic-hydraulic cylinder. These arms are fitted with spring-loaded catches, which engage lugs on the mould during its removal.

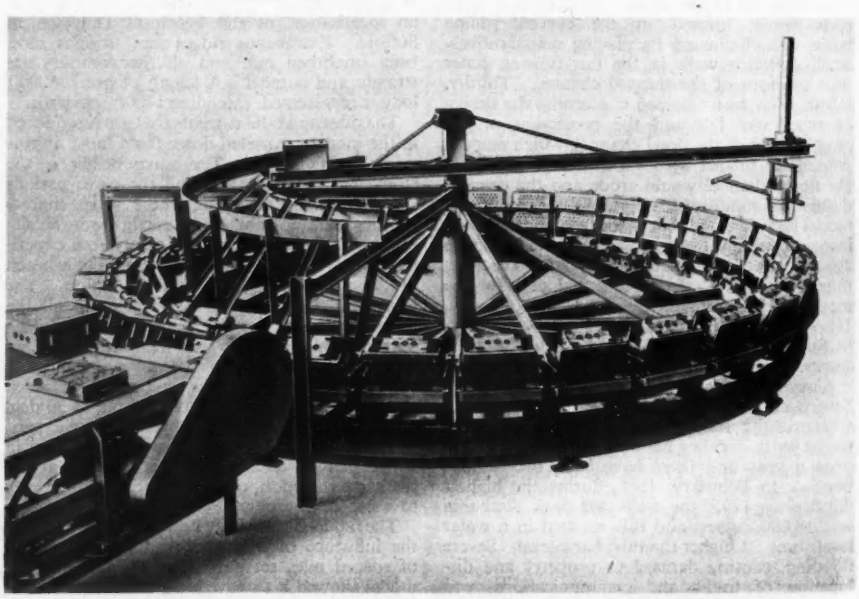
As the half moulds travel on the conveyor from the machine, coring is carried out and the matching halves are placed together before they reach a slip leading to the main rotating conveyor. On the outer ring of the track at each station on this conveyor there is a mould clamping pallet mechanism. Each of these units consists of a base with a spring-supported top, and is pivotally mounted about the bottom pallet between two upright supports. On each pair of pivot members two links are loosely fitted, one each side of the mechanism, and these links are connected together with a steel bar which projects a short distance through each link. This bar is provided with a pressure pad in the centre. A roller fitted to the underside of the mechanism engages with a cam rail controlling the angle of tilt. When the mechanism is tilted, clamping is effected by the projecting ends of the link pressure pad forcing the top plate downwards on to the mould.

When the mechanism is restored to the horizontal position by the roller engaging with the cam rail, the clamping pressure is relieved and the springs thrust the top plate up to facilitate the removal of the mould. This pallet mechanism is so designed that any unevenness of the sand face does not interfere with the ultimate contact of both box parts, and the mechanism is aligned about the major pouring axis of the box. The clamping arrangements are arranged to resist any ferrostatic pressure likely to be encountered, and thus prevent any possibility of metal leakage.

At the pouring station a ladle and carrying handle are supported in a self-adjusting cradle suspended from a swinging arm so that the ladle moves around an arc the centre of which coincides with the centre of the rotary track. The cradle has two hooks and is supported by a compression spring, which, in addition to permitting rotary and vertical movements, also allows the ladle to be moved inwards or outwards as desired. The arm from which the mechanism is suspended rotates about the centre of the mould conveyor and has a balance weight fitted at the opposite end to facilitate rotation and eliminate operator fatigue. The cradle support spring is loaded to equal the weight of the cradle handle assembly and consequently it adjusts its height as the metal poured reduces the total weight of the assembly.

The shake out is a conventional vibratory frame machine fixed to the foundry floor and positioned over an underground sand return conveyor. At this station the operator puts the castings on to a wire mesh conveyor running to the fettling department and the box parts are placed on a gravity roller conveyor, returning to the moulding machine to complete the cycle.

The used sand is carried by the underground conveyor beneath a magnetic separator, to remove any foreign ferrous metal, before the sand is discharged into a bucket elevator and raised to a rotary screen above the storage hopper. Beneath the storage hopper is a measuring hopper for discharging a given quantity of sand into the mill. When the sand leaves the mill it is discharged into a disintegrator, where it is broken down into a free-flowing consistency, to be raised once more into the reservoir hopper supplying the conveyor of the moulding machine. Both sets of discharge double "chop gates" on the storage and measuring hoppers and the dis-



Rotating mould conveyor with mould closing and loading station on the left, and pouring station on the right. As the moulds are loaded they are automatically clamped in a vertical position for pouring

charge door on the sand mill are under the control of an automatic sequence gear operating solenoid pneumatic valves, which in turn work the air cylinders of the appropriate openings.

Incorporated in the time cycle of the measuring hopper discharge is a solenoid water valve, which is fitted to a spray pipe round the mill crib. This valve may be set according to the type of work being produced and automatically adds water in the required quantity to maintain the moisture content. This sand plant is made by Pneulec, Ltd.

Bulk Oil Dispensing Vehicle

TO effect a major reduction in the cost of distributing lubricating oils in discrete packages, Shell-Mex and B.P., Ltd., are to bring into use a fleet of 900-gallon tankers carrying six grades of oil separately. The vehicles also have lockers to accommodate drums up to five gallons and other containers.

These tankers are based on the bonneted Dennis " Pax " chassis with wheelbase 12ft 10in, front track 5ft 11 $\frac{7}{16}$in at wheel centres, rear track 5ft 6$\frac{3}{4}$in, and turning circle 51ft. The chassis is powered by the four-valve, six-cylinder diesel engine with bore 98mm and stroke 112mm, 5060 c.c. displacement, developing 87 b.h.p. at 2000 r.p.m., and driving through a four-speed and reverse gearbox and spiral bevel final drive to provide overall ratios :—

Top gear	6·14 to 1
Third gear	10·68 to 1
Second gear	19·48 to 1
First gear	38·61 to 1
Reverse	49·96 to 1

The tyres are 8·25×20 twelve-ply all round, singles, front, twins, rear.

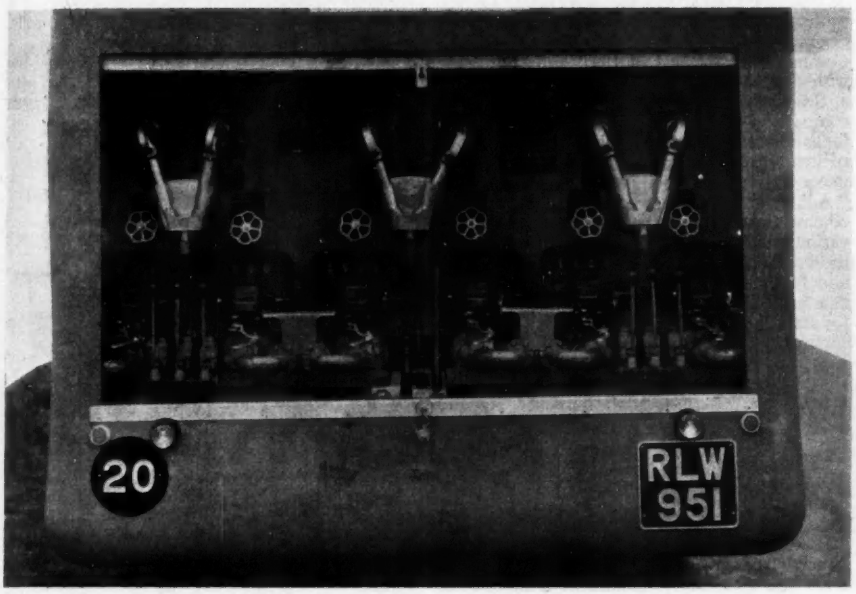
The chassis power take-off providing the drive for the pumping equipment is Messrs. Dennis Bros.' full power top drive type with the off-take point immediately above the transmission shafting and conveniently matching the compartment pumps which are mounted along the underside of the cargo tank.

Dennis Bros. have installed remote hydraulic controls for the engine, power take-off, and clutch, and electric circuits allowing the engine to be started or stopped, all at one central control station at the rear of the chassis adjacent to the pump, meter and hose reel controls. The clutch and power take-off controls are arranged to interlock to assure the clutch being completely disengaged before engagement or disengagement of the power take-off.

The cargo tanks and the auxiliary dispensing equipment for the new vehicles are being provided by Messrs. Thompson Bros. (Bilston), Ltd.

The tank shells are elliptical in section, 5ft 3in by 3ft 9$\frac{1}{2}$in, formed with six fabricated cruciform mounting feet and secured to the chassis frame by " U " bolts following normal practice. Six compartments are provided, three of 200 gallons nominal capacity each and three of 100 gallons capacity, the bulkheads being dished alternately in opposite directions, with open fill lids and dipping points adjacent. To the rear of the cargo tank on the frame overhang is mounted the whole of the meter/hose reel dispensing equipment, the cargo tank being fully panelled and providing access to the pumping equipment by means of a roll shutter at the rear.

The individual cargo pumps are mounted directly on the underside of the tank shell, in line, and are driven by a Hardy Spicer cardan shaft directly connecting with the top drive power take-off. Layrub couplings between the pumps provide a continuous drive throughout, No. 6 pump shaft extending rearwards to continue the shafting to two 90 deg. transfer boxes driving a transverse shaft which actuates the hose reels for mechanically reeling the hoses.



The dispensing equipment in the rear compartment of a pre-production version of the 900-gallon tanker. The six hose-reel control levers have now been made to fold for easier access to the meters. The nozzles are resting in pairs, in the drain hoppers, which are piped to a common sump. The short and long levers in the centre engage the power take-off and the clutch respectively

The oil handled by the individual pumping sets flows first to the directly-mounted Varley DH.20 pumps, providing a nominal pumping rate of 12 g.p.m. per pump, and thence by separate pipes rearwards to the individual pump control valves which allow the oil to be freely circulated back to the respective compartments ; when the pump control valves are screwed down they close off the compartment return lines, while at the same time acting as individual pump pressure relief valves. The pump control valves also form part of a Shell-Mex and B.P. air separator arrangement normally in use for lubricating oil deliveries. This is effected by providing a bleed for air through the relief valve, the return pipes running above the pressure pipes. The oil pressure generated across the control valves supplies the individual " Quantrol " preset type meters via Brodie-Kent strainer units and thence (when the preset valves are opened) via the 25ft by 1in smooth bore reeled hoses to the customer's storage, the delivery lines terminating in plain non-controllable " nozzles " with integral check-valves set to approximately 35 lb per square inch opening pressure.

Delivery to the customer is effected by setting the meter preset index to the desired amount, zeroising the meter delivery counter, and opening the meter valve, the meter valve automatically closing subsequently on exhaustion of the selected delivery quantity. The meter continuously shows the amount yet to be delivered and the total quantity passed.

The delivery hoses are pulled out by hand, running freely outwards, but are reeled in mechanically. On completion of a delivery and following automatic meter cut-off as described above, the pump for that particular oil can be unloaded by the operator unscrewing the pump control valve loading handwheel, conspicuous in the illustration. The nozzle is then hung on one of the two reeling hooks and the hose reel drive engaged by the appropriate one of the six control levers seen mounted in banks of three. These levers each move the piston in the master cylinder of a hydraulic circuit ; the slave cylinder drives a friction roller in between one of the wheels on the transverse shaft and the rim of the appropriate reel. The wheel size is so chosen that the hose is drawn in at walking speed. A pair of self-aligning plummer blocks support the shaft at each wheel. An interesting detail of the auxiliary transmission is the arrangement for positive lubrication of the output bearings of the lower bevel box ; oil trapped between one pair of teeth on the bevel is forced past a gravity-loaded ball valve and up the drilled shaft to return through the ball and roller bearings. The fluid handled is fed to the hoses through the spindles of the hose reels ; a single Weston oil seal acts as a gland in the rotary coupling.

The panelling enclosing the tanks and dispensing gear is of light alloy on welded steel frames, the part behind the rear wheels being detachable in one piece for maintenance purposes. At the nearside front, a set of flush-steps fold out in unison to give access to the tank tops for filling and dipping. The unladen weight of the vehicle is approximately 5 tons, and the laden weight 9 tons 2 cwt.

On a visit to Thompson Brothers' Bradley Engineering Works, Bilston, one of these vehicles was demonstrated to us. Immediately impressive was a close and consistent control of engine speed by a pneumatic governor. Calibrated five-gallon containers, left to drain and to settle for prescribed periods, were then used to prove the accuracy of the meters. Presetting is in increments of 0·1 gallon, and the spring-loaded nozzle valve shuts sharply when the meter valve closes, so that the quantity delivered is effectively independent of the technique of the operator or the elevation of the customer's tank.

Canadian Structural Engineering Firm's Expansion Programme

AN expansion programme, valued at 20,000,000 dollars, has been announced by the Dominion Bridge Company, Ltd.; it will increase the company's productive capacity throughout Canada by approximately 40 per cent and will be carried out over a four-year period. The company's nine main and six subsidiary plants will be affected and the expenditure for expansion has been allocated in approximately equal proportions among the four regions, Eastern, Ontario, Western and Pacific. The programme involves considerable increases in capacity for fabricating structural steelwork, plate and boiler shops, light manufacturing capacity, and new storage buildings and offices.

HOPPER LOADER FOR INJECTION MOULDING MACHINES.—An automatic self-contained hopper loading equipment for injection moulding machines is now being marketed by Fawcett Finney, Ltd., Berkley Street, Birmingham, 1. With this equipment the granular moulding material is drawn through a vibrating suction tube from bags or drums and delivered by a compressed air venturi nozzle and flexible pipe to the machine hopper. When the material in the hopper reaches a predetermined height the air supply to the venturi is shut off until the machine timer restarts the loading cycle. With air at 25 lb per square inch up to 7 lb of material a minute can be handled by the loading equipment.

Fires in Ships

A SYMPOSIUM on "Fires in Ships" was held on Tuesday, October 23rd, at 85, Minories, London, E.C.3, before a joint meeting of the Institute of Marine Engineers and the Institution of Naval Architects, when four papers were presented dealing with various aspects of the subject; they are summarised below. Mr. F. J. Welch read the first paper, which was entitled "Survey of the Causes and Methods of Extinction of Fires in Ships." The subject matter is based upon a study of fires officially reported and a table sets forth the causes of fires in British ships during the last five and one-half years, and indicates that fires in port are double those at sea. Cargo and cargo space fires and the various methods for their detection and extinction are discussed, together with their advantages and disadvantages. The causes of fires in accommodation are mentioned and the general means for extinguishing them recounted, attention being called to the toxic fumes of carbon tetrachloride. With regard to machinery space fires, emphasis is on the need for cleanliness and the reduction of fire risk if auxiliary boilers in oil-engined ships were placed in gastight casings. Internal fires in oil engines and crankcase explosions are referred to, and it is mentioned that steam temperatures in turbine-engined ships are at a level to cause spontaneous ignition of lubricating oil. To extinguish engine-room fires the obvious value of an early alarm and shutting off the oil supply are underlined, together with the use of foam extinguishers for the initial attack. General procedure is outlined and the employment of carbon dioxide, steam or water spray. Considerable stress is laid upon the importance of closing openings and there are notes upon breathing apparatus, explosions from coal gas and the avoidance of capsizing due to loss of stability caused by the building up of free surface water. The paper concludes with a number of suggestions for effecting a reduction in the fire risk at sea.

In the second paper, "Principles of Fire Organisation in Ships at Sea and in Port," by Lieut.-Colonel A. G. Bates, materials in relation to the fire risk are discussed, including the dangers of over-emphasis upon fireproof materials, the fire potentials of cargo, the question of using insulation with aluminium alloys, and the use of wood. Pointers are given for the prevention of fires, such as a close check upon the cargo and its stowage, a good organisation to minimise the risk through the human element, and the need for additional vigilance in port, due to the presence on board of many persons not under any discipline. Instances of unpredictable risks for which no provision can be made are given, and also of the unforeseeable dangers arising from insufficient description of items of cargo. Sprinklers and smoke detectors as extinguishing and automatic warning systems are in common use and the latter, it is noted, cannot operate in holds when the hatches are off. Sound training of personnel is put forward as a must and also the organising of defence in depth, both for dealing with fires at sea and in port. An appendix records the main details of fire incidents in two passenger liners over a period of twelve years.

Mr. L. T. Carter, and Captain H. C. Hogger, R.N., were the joint authors of the next paper. This paper, entitled "Naval Procedure in relation to Fire Organisation," is a résumé of the fire-fighting organisation and methods used to combat fires in the Royal Navy, beginning with a short historical survey from 1730 onwards. Early trials using foam and steam drenching arrangements in boiler-rooms are mentioned, followed by notes upon specific instances of fire damage during the second world war. It is stated that since the war analysis of fires has not indicated that present equipment and methods are wrong, and general considerations of fire-fighting requirements to-day are discussed. What fire protection involves in a ship is briefly mentioned, together with the problems of fire prevention as related to fittings and constructional materials. Fire mains and pumps are broadly discussed, also the special properties of foam and the fitting of spray systems in compartments where severe hazard exists. There is particular reference to fire fighting and fire prevention in machinery spaces, and to the problems associated with various stowages, the special hazards on flight deck and in hangars, and the fire protection provided. First aid equipment at present in use is described and remarks made upon portable fire pumps, the development of breathing apparatus and the evolution of protective clothing. Sections of the paper are concerned with the fire organisation on board ship at sea and in harbour, the training of the personnel, and the problems to be faced in arctic weather conditions. The paper concludes with brief reference to standardisation, and to research and development programmes.

Paper number four, "Research in Relation to Ship Fires," was presented by S. H. Clarke and S. A. Hodges. The paper summarises the history and experience which have formed the basis of the approach to fire protection in passenger ships in this country, beginning with the British Fire Prevention Committee established in 1897, and continuing with the main particulars of the Safety of Life at Sea Conventions of 1914, 1929 and 1948. A comparison is made between ship and building fires and notes are given upon the general principles of structural fire precautions. Work carried out in connection with the fire resistance of prototype "A" and "B" class structures is described and comments made upon the experience gained with various materials. The three tests concerned with the behaviour of construction materials, fabrics and furnishings in fire, namely, those for non-combustibility, for surface spread of flame, and for flammability of materials in sheet form, are summarised and a table recording the behaviour of typical materials included. There is reference to the toxicity of combustion products, the benefits derived from good housekeeping and the value of the immediate detection of fires by the "live watch" or by automatic fire detectors. Following a section dealing with sprinklers the paper goes on to give notes upon a number of extinguishing agents, such as water, foam, vaporising liquids, carbon dioxide, dry powder and wetting agents. It is stated that a lesson learned from major ship fires is that disasters often occurred due to failure of a number of precautions and the paper includes some suggestions, put forward by fire officers, with regard to the control of ventilation.

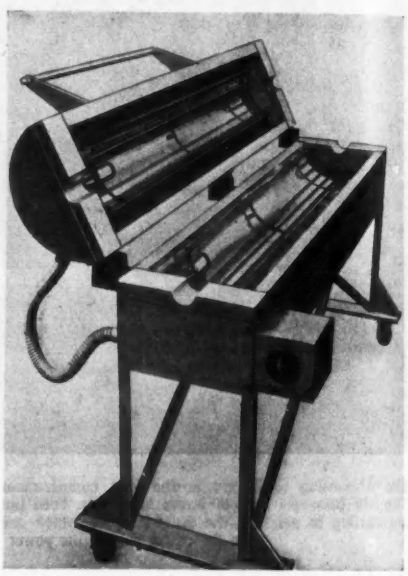
On Wednesday, October 24th, those attending the symposium travelled to Gosport to pay a visit to the Admiralty Establishments at Haslar. After an introductory talk by Dr. Gawn, the Superintendent of the Admiralty Experiment Works, and by the Officer Commanding Admiralty Fuel Experimental Station, the members were able to witness a number of fire-fighting demonstrations on the fire test ground. Service fire-fighting clothing was shown, a high-flash-point diesel oil fire was put out by use of a gas/water extinguisher, and a chemical foam extinguisher was used on a low-flash-point oil fire, while there was a demonstration of a dry chemical extinguisher on a diesel oil fire. The use of carbon dioxide for dealing with an electrical fire in a wireless cabinet was demonstrated, this form of extinguisher now being preferred to carbon tetrachloride owing to the toxic products from the latter. Also on view were a mechanical foam generator and the foam injection method dealing with a fire such as may occur in the casing of an enclosed boiler, or in inaccessible bilges. The efficiency of a foam making branch pipe equipped with a snowflaking device was demonstrated on a diesel oil fire and the "Phœnix explosive compartment" was used to illustrate the dangers of explosive re-ignition in a compartment which is still hot. The right and wrong way of attacking a fire in a fish fryer was made clear, the wrong method being the employment of a gas/water extinguisher and the right way being by foam. The final demonstration was the rescue of a pilot from a crashed aircraft and the control of the resulting petrol fire. Rescue teams clad in protective clothing tackled this problem using dry powder and snowflake foam equipment, the rescue of the pilot being carried through by one member of the team, while a second member operated the dry powder equipment.

While at Haslar the members were able to visit the Admiralty Experimental Works to see the towing tank technique, the development of the manœuvring basin, and both the 2ft square water tunnel and the new tunnel which has a cross section of 8ft by 4ft. At the fuel station the testing of refractories was observed, also the development of oil fuel burners and nozzles and a torch igniter.

Infra-Red Curing of Varnish and Lacquer on Photo-Lithographic Rollers

BEFORE the photo-lithographic rolls, used by the printing trade, are etched they have to be varnished or, alternatively, coated with a bitumastic powder to produce an acid-resistant surface. This surface has to be heat cured and in some cases a heater similar in design to a calender heater was threaded into the rolls, which were usually of solid copper.

A cheaper and lighter roll is now extensively used, consisting of a thin copper tube with steel end pieces. With this new type of roll even heating with a calender type heater is not always possible, due to the change in thickness of material from the ends to the main portion of the roll.



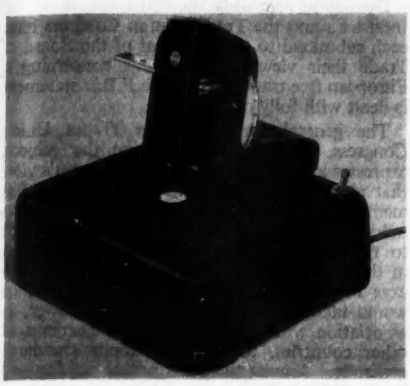
Infra-red heater for curing varnish and lacquer on photo-lithographic rollers

To accommodate the new shell rolls and the older solid rolls a heater has been developed by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. Mounted on castors for easy handling, the heater consists essentially of two anodised aluminium reflectors fitted with "Metrovick" tubular sheathed infra-red heating elements. The electrical loading is approximately 3kW per foot of heater length, giving a processing time of approximately ten minutes. Simple switching is provided to bring additional end elements into use when processing shell rolls with solid end pieces.

SEALING RINGS.—The Pioneer Oilsealing and Moulding Company, Ltd., Colne, Lancs, has introduced a new form of synthetic rubber sealing ring to replace O-rings for certain applications. The new rings are of square section with annular grooves in each side. This shape is stated to eliminate spiral twist in service and reduce the frictional resistance as compared with that of O-rings for pressures up to 600 lb per square inch.

Colour Densitometer

THE instrument illustrated is a simple transmission densitometer recently developed by Kodak Ltd., Victoria Road, Ruislip, Middlesex, for density measurements on colour and black-and-white transparencies. The chief application of the densitometer is for the standardisation and control of the many photographic stages of colour reproduction. It is very useful for making colour correction masks and colour-corrected separation negatives from "Kodachrome" and "Ektachrome" transparencies. In addition, it is also useful when masking from reflection copy



A comparator instrument for assessing the densities of transparencies in white, red, green or blue light

using either the overlay masking or the magenta masking techniques. It has a further application in making colour prints either directly from positive or negative colour transparencies or in making matrices for dye transfer printing.

By means of the densitometer, black-and-white printing can be put on a scientific basis, for with its aid the photographer can determine what contrast grade of paper to use, and he can also accurately predict exposure times in printing.

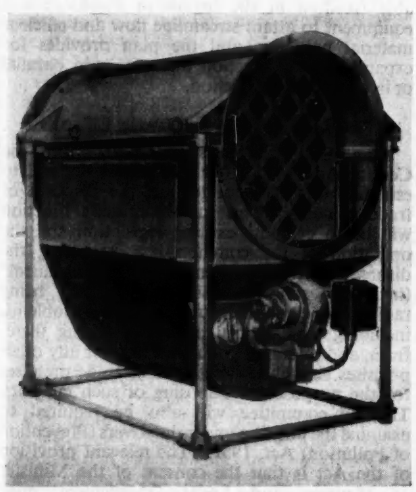
The instrument works on the comparator principle: the rotatable annular density wedge is made of a stable clear plastic in which are dispersed graphite granules. It is not affected by voltage fluctuations and an occasional check of the zero setting is all that is needed to secure accuracy. Below the eyepiece can be seen a slide carrying red, green and blue filters for measuring the densities of those colours. Measurements can extend to the centre of 8in by 10in film.

Air Heating

AN oil-fired heat exchanger that offers hot air for space heating or industrial and agricultural drying processes, without the complication and capital cost of steam or hot water plant, has been introduced by Vaporheat, Ltd., 47, Victoria Street, S.W.1. That illustrated is the "COB 300" and has a heat output of 300,000 B.Th.U. per hour. It will deliver 8000 cubic feet per minute of air heated 34 deg. Fah. against 0·75in water gauge with a single-stage, or 3·5in with a two-stage, 30in "Aerofoil" fan. A temperature rise of 98 deg. Fah. can be maintained at 2500 cubic feet per minute, using a 19in fan fixed by means of a transformation duct section to the 30in flange seen in the illustration.

The combustion air is handled by a fully automatic oil burner, controlled thermostatically or by a time clock: protection is given against flame failure, incorrect air outlet temperature, and excessive current consumption.

The heat exchanger itself is made of stainless steel and has an efficiency of between 77 and 86 per cent: this figure will clearly depend on the delivery temperature required. Other sizes under development are 24in, 38in and 48in diameter; in all cases Woods "Aerofoil" fans are used.

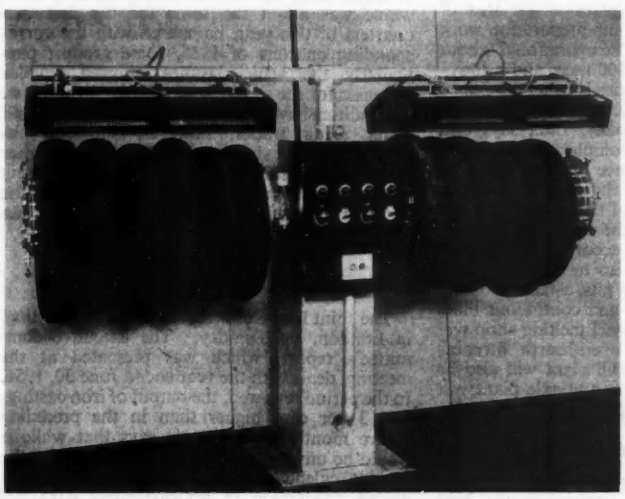


Oil-fired heat exchanger for space heating or industrial drying

Tyre Drier

THE two processes in common use for remoulding and retreading tyres for road vehicles both require the tyre to be previously dried out.

In the remoulding "bead-to-bead" process it is essential that the tyres are completely dry prior to the application of new rubber to avoid any risk of trapped moisture, as otherwise "ply" separation would occur on curing. To a lesser degree this applies when the "top and full-capping" process is used. For "bead-to-bead" remoulding the old rubber is stripped off to provide a suitable surface for rebuilding, and



Infra-red projector outside, and tubular sheathed elements inside, drying tyres before remoulding

at this stage it is necessary to dry out the fabric. If, in the worst case, a tyre is cut and the fabric exposed, moisture may have penetrated the strands and travelled round the tyre. Such a condition would be aggravated by storage in the open.

The accepted method of drying has been to stack tyres in a room heated by steam coils for some three to five days, dependent on the size of the tyre and its moisture content. This arrangement is very uneconomical in time, space and fuel, particularly as the heat must be maintained during week-ends for tyres to be ready for processing at the beginning of the week.

A new drying equipment has recently been manufactured by the Grantham Electrical Engineering Company, Ltd., for Vacu-Lug Traction Tyres, Ltd., Grantham, which reduces the drying time of a moisture-laden tyre in the passenger tyre range to 1½–2 hours. Heat for the unit is provided by standard Metrovick infra-red projectors mounted above the tyres, and Metrovick tubular sheathed elements inside the tyres; working temperatures are reached within a few minutes of switching on.

Two horizontal revolving drums fixed to a central pedestal can each carry six passenger type tyres. As the drums rotate the tyres are subjected to radiant heat from the projectors and internal heating from the tubular sheathed elements, which remain stationary, thus avoiding the use of sliprings. Heat output is controlled by energy regulators housed in the pedestal, and, in addition, the distance between the projectors and the outer surface of the tyres can be varied.

Moulded Polythene Tube Fittings for Plumbing Systems

DURING the past few years there has been a considerable increase in the use of polythene tubes for domestic and industrial purposes where the elastic properties of the material practically eliminate the risks of fracture due to freezing and where the degree of acid and alkali-resistance is of value. One of the disadvantages which has been experienced, however, is that the fittings such as couplings, elbows, tees, reducers and adaptors which had to be used with the tubes, were metallic. In order to overcome this disadvantage, Imperial Chemical Industries, Ltd., has now introduced a range of standard moulded polythene fittings for use with its "Alkathene" tubes, which are quick and easy to fit.

These new fittings are made for the ½in, ¾in and 1in norminal sizes of the normal gauge "Alkathene" tubes and are actually bonded in to form a composite part of a plumbing system. Each fitting has bonded into each of its sockets during manufacture two rings of metallic resistance strip. These strips form a small heating element and two leads projecting from the element extend beyond the end of the socket to provide electrical connectors. When a low-voltage current at moderate amperage is passed through the elements, sufficient heat is produced to cause localised melting of both the tube and the fitting to weld them together.

The makers state that a well-charged 6V, three-cell, heavy-duty battery of 50Ah to 60Ah capacity is well suited for this welding operation of the fittings on the pipes, which requires a current of about 28A. The welding operation takes from fifteen to thirty seconds and its completion is indicated by the escape of a small drop of molten polythene from the point where the connector wire leads into the fitting. To assist users in training operators in the application of the fittings a simple automatic timer has been developed. This timer can be dispensed with by the average operator after a brief training period, and cables made to standard lengths to control the current input to the elements can then be used.

In making a joint it is essential to insert the tube right up to a stop in the socket of the fitting, and to ensure that the operator can see when the tube is in to the correct depth a simple checking measure is provided. After the end of the tube has been cut off square it is laid across the top of the socket and the diameter size of the socket is scratched with the thumb nail down the length of the tube. When the tube is then pushed in the socket the correct depth of insertion is shown when the scratch reaches the socket rim. After all the joints in a plumbing system have been made a normal liquid pressure test can be carried out. Any joints which might leak can then be rewelded when the pressure is released, but without need for emptying the system. When installation and testing have been completed the wire connectors of the fitting elements are cut off to leave a smooth surface.

Industrial and Labour Notes

Durgapur Iron and Steel Works

In these notes in our issue of April 27th, some preliminary information was given about the construction and equipment of an iron and steel works for the Government of India. The works will be built at Durgapur, in West Bengal, by thirteen British firms, which have formed a consortium entitled the Indian Steelworks Construction Company, Ltd. The decision to build this works at Durgapur followed recommendations made by a Colombo Plan mission which visited India, under the leadership of Sir Eric Coates, in April, 1955. Durgapur lies 110 miles north-west of Calcutta on the main Calcutta–Delhi railway, and on the Damodar River.

Last week the final contract for the project was signed in Delhi, and details concerning it have been issued by the Indian Steelworks Construction Company, Ltd. (Iscon). The value (f.o.b.) of the plant, equipment and materials to be supplied from this country will exceed £50,000,000, and the arrangement is that costs of work to be carried out in India by the consortium—including civil engineering work, the fabrication of about 33,000 tons of steel, and various local purchases—will be paid for in rupees as the work proceeds. It is stated that the iron and steel producing sections of the Durgapur works will have a rated capacity of 1,250,000 tons of ingots a year and 360,000 tons of pig iron. For the rolling mill and the railway wheel, tyre and axle plant, the output has been estimated provisionally at 790,000 tons a year.

The Durgapur works will cover an area of about 7 square miles, and site preparation work has already been started. The operational labour force will number about 7000 men, and a township with up-to-date amenities is being developed by the Government of India. The Indian Steelworks Construction Company, Ltd., says that the entire works will be completed by August, 1961. The first blast-furnace is to be blown in by November, 1959, and the second by May, 1960, and the completion of the first and second coke-oven batteries, with the necessary ancillary services, will be arranged accordingly. Part of the steel-making plant is also to be installed by May, 1960, and the soaking pits, a 42in blooming mill, the intermediate mill and continuous billet mill. By May, 1961, the steel melting shop will have seven of the nine open-hearth furnaces installed, and the rolling mill plant will also be completed. The wheel, tyre and axle plant will be finished three months later.

Cost of Labour Turnover

At the end of last week, the British Institute of Management's annual conference was held at Harrogate, the general theme for the discussions being "Management, Profits and Living Standards." One of the papers, presented on Thursday of last week, was by Mr. R. L. Webster, and dealt with the cost of labour turnover in industry.

Mr. Webster derived the statistics included in his paper from a pilot survey carried out by the British Institute of Management amongst sixteen firms. He said that the rate at which people were at present changing their jobs was costing manufacturing industry £230 million annually, and if all employed persons were included, the cost to the country as a whole was perhaps £700 million. To this, Mr. Webster added his conclusion that, in the manufacturing industries, labour turnover was in the region of 41 per cent for men and women jointly, and that for men the figure was probably about 35 per cent and for women about 54 per cent annually.

Mr. Webster ended his paper with a reference to some of the conclusions set out in the pilot survey. First, he said, an estimate of the cost of labour turnover would help managements to judge the significance of the problem, and, secondly, a cost analysis of the tangible factors in labour turnover would enable managements to judge whether these or the intangible factors were the more important. Finally, Mr. Webster suggested, even if the level of labour turnover remained obstinately high in spite of all efforts to tackle the problem, a cost analysis might itself suggest ways in which the tangible cost could be reduced. A very obvious example was the case of redundancy. Study of labour turnover costs might enable management to decide which was the more economical policy: to keep workers on the books during a slack period or to discharge them and face the probability of having to recruit a similar number back again in a few months' time. Cost might not be the only factor to influence such a decision, but it was nevertheless an important one.

Capital Expenditure

According to the *Board of Trade Journal*, the provisional estimates of changes in fixed capital expenditure during the second quarter of this year have not been altered very much by the returns of actual expenditure which companies have submitted. The details which the Board has received indicate that, in the second quarter of 1956, the high level of capital outlay continued, with expenditure by manufacturing industry about 25 per cent higher than a year earlier. In the shipping industry, however, and in the miscellaneous group of distribution and service industries, expenditure in the second quarter was only a little above that of a year earlier.

The Board of Trade says that while the increase in expenditure by manufacturing industry as a whole was about the same for the first two quarters of this year, compared with the corresponding quarters of 1955, some groups, particularly the vehicle trades, showed smaller increases for the second quarter than for the first. Expenditure by the metal manufacturing and metal using trades, however, showed substantially larger increases over a year earlier than they did in the first quarter. Manufacturing industry's total capital expenditure during the first half of this year was 27 per cent higher than in the first half of 1955.

The Joint Iron Council

The Joint Iron Council held its annual meeting, in London, on Tuesday. The executive committee's report, which was presented at the meeting, deals with the year ended June 30, 1956. In the period reviewed, the output of iron castings was 3 per cent higher than in the preceding twelve months. The report says that while it would be unwise to forecast total output for the current calendar year, it seems likely that a record production of approximately 4,000,000 tons may be achieved.

The report goes on to say, however, that the fortunes of the different sections of the ironfounding industry have differed widely, and "appear to reflect something of the effects of the redeployment of national economic resources." These effects, the report continues, are not solely confined to the building and automobile sections, but appear also in the engineering and jobbing section where the increases in outputs of castings for the heavier capital goods industries (notably the electrical engineering industry) tend to be greater than for the lighter industries.

The council's annual banquet, at the Dorchester Hotel, on Tuesday evening, was attended by a company numbering about 600. The president, Mr. N. P. Newman, was in the chair, and the principal guest was Sir Edward Boyle, Bt., Economic Secretary to the Treasury. Proposing a toast to "The Iron Industry," Sir Edward said that he saw no reason to take a gloomy view of Britain's industrial future. He spoke about the part played by the ironfounding industry in the economic situation, and emphasised the importance of training, research and development. During the evening, the president, Mr. Newman, presented an address, bound in leather, to Mr. Winthrop Brown, United States Minister for Economic Affairs in the United Kingdom. The address records the Joint Iron Council's appreciation of help given, by Conditional Aid funds, to promote technical training in ironfounding, and research concerning health and safety and fuel economy.

European Free Trade Area

During the past week, the Federation of British Industries and the Trades Union Congress have each submitted to the President of the Board of Trade their views on proposals concerning a European free trade area. The F.B.I. statement is dealt with fully on page 663.

The general council of the Trades Union Congress, in a memorandum on the subject, expresses agreement with the Government's view that although Britain could not become a full member of the proposed European common market and customs union, she could not afford to remain aloof from economic developments in the rest of Europe. The memorandum also says that the T.U.C. and its affiliated unions would take what action was in their power, in association with the trade union movements of other countries, to improve labour standards generally. Among the other points put forward by the T.U.C. there is one which urges that the Government should be able to take adequate measures to offset any threat of unemployment in particular industries.

Opening of Oil Seal Factory

A new factory for the oil seals division of George Angus and Co., Ltd., was opened recently by Major G. Lloyd George, the Home Secretary. This particular division of the company, which was formed in 1788, started operation twenty years ago and since the existing works could not be extended, to permit of increased production, a new site of 19 acres was acquired at Wallsend. Close co-operation between all concerned in the building of the factory has resulted in the whole scheme from conception to completion taking only eighteen months. Work began on the site in April last year and by July of this year production had started.

The works and office buildings cover an area of about 250,000 square feet and the latter include two blocks of laboratories, an office block and a canteen and administration block. These buildings, of steel frame construction, have curtain walling and flat roofs, except for the canteen, which has a barrel roof, while the design allows for expansion by the addition of further floors. The factory, which lies behind the main buildings, has a floor area of 158,400 square feet and has been constructed on the basis of a 60ft module. This has permitted considerable freedom in the layout of machines and equipment to attain streamline flow and efficient material handling, and the plan provides for expansion of production lines either in parallel or in a lengthwise direction.

The Law Dealing with Trade Effluents

At a meeting on Tuesday, October 30th, the Central Advisory Water Committee decided to establish a sub-committee on the disposal of trade effluents. This sub-committee's function will be to examine existing legislation and the operation of the common law respecting the disposal from trade premises of liquid effluents (including solids in suspension), not being radioactive effluents; to examine the problems, including the financial problems, arising therefrom, and to consider whether farm or any other premises should be designated as trade premises for the purposes of disposing of such effluents. The sub-committee will also be required to examine the position under the Rivers (Prevention of Pollution) Act, 1951. The relevant provision of the Act is that the consent of the Minister of Housing and Local Government must be obtained before a river board can take proceedings.

African Engineering News

BY OUR SOUTH AFRICAN CORRESPONDENT

"Remote Control" on the S.A.R.

"Remote Control," which was first introduced by the South African Railways over a short section of the main line south of Kimberley, has proved so successful in speeding up the movement of traffic that it is to be extended on a Union-wide basis. This modern system of arranging the crossing of trains at unattended interloops by push-button control from a station miles away is a modified form of centralised traffic control (C.T.C.), and is primarily designed to expedite traffic over single lines and thus increase carrying capacity. Up to fifteen minutes can be saved at every crossing by employing this method. Since the introduction of remote control last year the system has been extended to all interloops between Modder River and Warrenton, on the Johannesburg–Cape Town main line and on August 6th this year was introduced at Britten to control Kromellen-Boog and Ferndale. By the middle of next year remote control will be in operation as far as De Aar, and will ultimately operate on the entire section to Touws River. The estimated saving of time on the Kimberley–Touws River section, where an average of 262 train crossings are made on every weekday, will be approximately sixty-five hours per day, based on an average saving of fifteen minutes per crossing.

Apart from the time-saving factor, remote control also cuts down the use of manpower to a bare minimum. It enables one trained man, constantly watching the movement of traffic on an electrically controlled illuminated panel from a central station, to set and reset points and signals and arrange the crossing of trains at interloops miles away merely by pressing individual sets of buttons on the panel. The interloops are provided with electric point machines to operate the points, home and starting signals for the main and loop line in each direction and intermediate home signals on either side. Everything is electrically operated and a panel in the signal cabin at the controlling station reflects the control and passage of any train as well as the aspects of the signals and the position of the points. Signals, tracks and points are fully interlocked and it is impossible to set up converging or conflicting routes. The entire system of controlling signals and points miles apart, and of giving visible indications on a panel, is done by means of two telegraph line wires and battery power, combined with a special system of relays.

Double Lines from Capital to Capital

When the Orange Free State doubling programme is completed, two of the Union's capitals, Pretoria, the Administrative capital, and Bloemfontein, the judicial capital, will be connected by a double railway line, a distance of 288 miles. Actually, there will be a double line from the Eastern Transvaal coalfields and the Witwatersrand gold mining area, through the Orange Free State as far as Bloemfontein, a distance of 334 miles. The second longest double line in the Union is, incidentally, at present being built between Durban and Ladysmith, a distance of 190 miles. The other major double lines in the Union are between Germiston and Vereeniging (40 miles), Springs–Randfontein (56 miles), Apex–Witbank (70 miles), Cape Town–Wellington (45 miles), and Durban–Cato Ridge, (44 miles).

As a result of these improvements, the carrying capacity of the line between Bloemfontein and Vereeniging will be increased from about 25,000 tons a day to more than 45,000 tons. Passenger trains will, for the present, not be affected, although the line has been shortened by 4½ miles, but goods trains are moving much faster over this section. A goods train which used to take sixteen and a half hours between Bloemfontein and Kroonstad now takes only eight and a quarter hours. The running times between Kroonstad and Vereeniging have also been reduced, although the work has not yet been completed. It is expected that the running time of goods trains over these sections will eventually be cut by about twelve and a half hours.

Another Dangerous Railway Level Crossing Eliminated

The recent official opening of the Modderdam road-over-rail bridge at Bellville marked the elimination of yet another busy railway level crossing. The bridge was built by the Railway Administration in collaboration with the Bellville municipality. Modderdam road carries a very heavy volume of road traffic, and the new bridge, which actually consists of two separate structures spanning eight railway lines, will afford safe access for some 10,000 road vehicles per twenty-four-hour day over a particularly busy section of railway activity. An average of 296 trains, 123 of which are passenger trains, at present pass over this section every twenty-four hours, which means that there is a train passing over the lines spanned by the Modderdam Road bridge every five minutes. Apart from the direct cost of the structures required to eliminate the old level crossing, it was at the same time necessary for the Administration to construct, in addition, two rail-over-rail bridges to provide for future improvements to the junction requirements at Bellville. The one, constructed under the main bridge, will serve to facilitate the departure of trains for the new marshalling yard to the main lines to the north, while the other will form a direct link from the Kuils River branch line and the industrial sidings to the marshalling yard.

Bridge Conveyed by Road from Durban to Kariba Gorge

Twenty-four lattice girders manufactured by a Durban firm were recently conveyed by the Road Transport Section of the South African Railways from Durban to the Kariba Gorge, Rhodesia, a distance of over 1500 miles. These girders will be used for the erection of a bridge across the Zambesi River just below the site of the new dam wall. The bridge will be a temporary structure to facilitate communication between the north and south bank during the construction of the wall and will, it is understood, be dismantled after completion of the hydro-electric scheme on the Zambesi River, when the road will then traverse the top of the nearly 400ft high wall. The girders, which measured between 30ft and 34ft long by 12ft 10in wide, were conveyed four at a time on 20-ton capacity articulated vehicles—two loads to the south bank and four loads to the north bank. Special problems had to be overcome in handling these unusual loads. No road existed to the north bank of the river, a distance of about 50 miles from the main road, and while bulldozers cut a road, the vehicles followed close behind them. In view of the abnormal size of the loads the vehicles were only allowed to travel during daylight.

The New Water Act

As important as any of the measures passed at the recent parliamentary session, at least from the viewpoint of industry, was the Water Act. The measure was long overdue, and the fact that it was the result of six years of investigation and consultation, reasonably suggests that it is a well-thought-out and effective addition to the statute book. The steady change in the economy in comparatively recent years whereby industrial development has reached up to challenge agriculture in its contribution, made it urgently necessary for industry's claim for water to be recognised much more clearly than was formerly the case.

Recognition of this is implicit in the intended change in the name of the Department of Irrigation to Department of Water Supply. Whilst no one would suggest, or indeed, has suggested, that riparian rights should not be retained, or that agriculture should not have a prime call upon water, the plan that farmers should be encouraged to undertake their own irrigation schemes, is entirely commendable. The incentive which the Act provides for this to be done should be effective, and to the extent that this is ultimately achieved the essential needs of mining and industry should be materially assisted.

It has often been claimed that South Africa is not bountifully supplied with water. That it is unequally and unreliably available is beyond question. The provisions of the Act and their implementation may eventually reveal that the first of these assertions is groundless. It will certainly help to relieve the difficulties inherent in the second. Even the most optimistic outlook for South African water supplies must still depend on the catchment and conservation of all water available, surface or underground, and provisions for this are contained in the Act.

Level of Vaal Hartz Weir to be Raised

The Vaal Hartz weir near Warrenton, Cape Province, is to have its level raised. The plan is to raise the half-mile long crest by several feet, and probably steel gates will be used. The gates could be opened during floods, and thus prevent the water level rising further than necessary. Raising the level of the weir will allow stricter control over the amount of water released from the Vaaldam and will reduce wastage of water. Increasing demands on the Vaal River by growing industrial areas now demand strict control. Water released from Vaaldam takes eleven days to cover the 362 miles to the Vaal Hartz weir. Over that distance the average loss is 320 cusecs. This loss may vary by as much as 100 per cent. The water used for irrigation at the scheme varies between 350 and 950 cusecs, depending on the time of the year and also on weather conditions. At present the water level at the weir can drop only by 6in before the discharge of the canal starts to fall off. With a higher weir this problem will be eliminated and excess water will not flow to waste past the weir. There are six ganging weirs between Vaaldam and the Vaal Hartz weir. Daily readings are sent by telegram to the Hydrographic Surveyor in Pretoria to ensure proper control and the correct amount of water being available at Vaal Hartz.

Big Irrigation Scheme in Natal

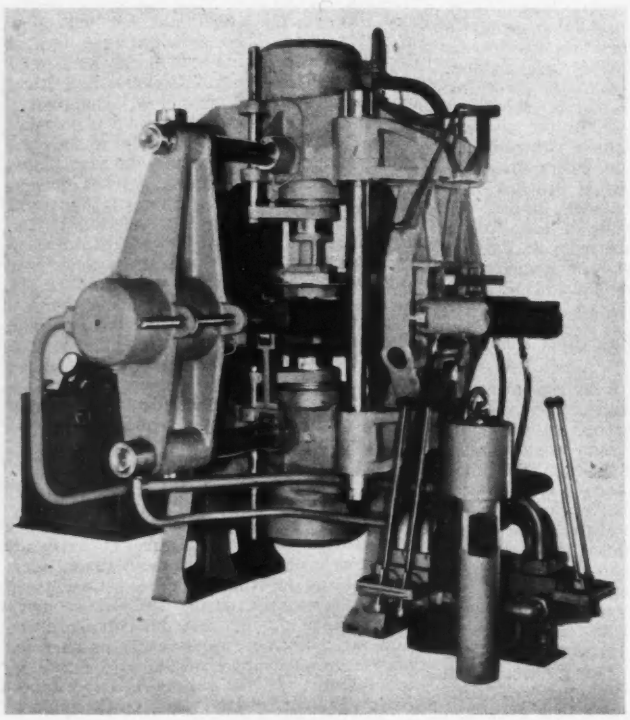
For at least 20 years, serious talk has been going on about the accruing advantages if a dam were constructed on the Makatini Flats of Natal, and hopes have now been strengthened by the Government having expropriated much land between the Pongola and Mkuzi rivers. How vast a scheme may ensue can be imagined when it is predicted that the dam would be about four times the size of Hartebeestpoort Dam. Though the land has been expropriated it has been leased back to the owners. The reason for the expropriation was that it was considered to be a wise economic step. Attention has naturally been directed to the site of the intended dam. A mountain village overlooks the Makatini Flats where they run for 50 miles from the base of the Lebombo mountain range to the sea at Sordwana, Kosi and St. Lucia. The village overlooks the site of the proposed dam which will be built across a gorge in the Lebombo mountains to provide for the irrigation of some 100,000 acres. About fifteen farms in Zululand and a strip of the Transvaal are affected. Many of these farms will be submerged, together with the railway siding of Candover. It is recognised that the dam must come first, before the flats can be settled with perhaps some 4000 families, and it is possible that the settlement will have to be linked by rail with the coast and the mooted plan of a harbour at Sordwana or Kosi, about 170 miles north of Durban.

Maritzburg's New Sewage Disposal Works

Maritzburg's new sewage disposal works should be finished by the end of this year. The works, which are highly mechanised, include 5 miles of 48in pipeline which runs underground beneath a row of Sobantu Village houses through a 400ft long tunnel. The pipeline crosses the Umsindusu River twice, and the supporting piles of concrete are on a solid foundation 21ft below the river bed. Each section of pipe weighs 2 tons. The complete area of the sewage farm is about 400 acres, and the disposal works will have their own chemical and biological laboratory. The Maritzburg City Engineer's Department has on its planning programme the future installation of a rapid gravity filter. Because of the relatively high rainfall, it should be possible to purify the effluent to a degree which will enable it to be pumped from the disposal works to the Mountain Rise industrial sites for industrial use.

Straightening Press

Our illustration shows a four-direction hydraulic straightening press made by Pitzmann and Pfeiffer K.G., Westliche 81, Pforzheim, German Federal Republic. The press is intended in particular for straightening rails. Owing to the great lengths nowadays employed—the German Railways use a standard length of 360ft—turning of the rail has become a difficult operation, thus rendering the use of a single-action press very cumbersome. As may



Hydraulic four-direction straightening press with 125-ton and 65-ton rams

be seen from the illustration, the press consists of four sets of pressure cylinders and rams carrying the straightening tools. Two cylinders are arranged vertically and two horizontally. Each ram is individually controlled by hand-operated pressure valves, of which there are a total of four, arranged in groups of two, at a convenient position for the operator who can thus control all movements with both hands. The levers operating the valves are single-directional, i.e. when pulling the lever oil is admitted under pressure to the cylinder; on releasing the lever the rams return automatically.

Hydraulic power is supplied from a totally enclosed unit consisting of a hydraulic tank with immersed variable-pressure pump, coupled to which is a flanged motor. The actual working pressure can be adjusted by means of a control valve and read off an oil pressure gauge. The press is thus completely self-contained.

The maximum pressure which can be exerted by the vertical cylinders either from the top or bottom is 125 tons, the horizontal pressure, either front or rear, 65 tons, with a maximum operating pressure in the cylinders of 200 atm. The stroke of the pressure rams is 115mm and 200mm respectively. The supports which serve as counter pressure points when straightening are adjustable between 760mm and 1360mm.

The maker is represented in this country by Embassy Machine and Tool Company, Ltd., 248, Watford Way, Hendon, London, N.W.4.

International Wrought Non-Ferrous Metals Council

The steering committee of the International Wrought Non-Ferrous Metals Council met in Copenhagen on October 18, 1956, and was attended by delegates from Belgium, Denmark, Finland, France, Germany, Great Britain, Italy, Portugal, Sweden and Switzerland. The Committee recorded its deep regret at the passing of Monsieur Albert Feron, a well-known and highly respected figure in the European, and particularly in the Belgian, wrought non-ferrous metals industry.

A review of the work now in progress was given by the Chairman of the International Council, Mr. Horace E. Jackson, C.B.E., which included, among other matters, a detailed study of substitution in the electrical industry and the creation of a library of technical films. Proposals are well advanced for the production of copper ingot bars in pallet form, and consideration is being given to standardising stacks of zinc slabs suitable for despatch in palletised form and also to the mechanical handling of copper cathodes.

Productivity surveys are taking place on the manufacture of brass rods and copper tubes; a working panel has been set up to consider and study costing methods in member countries and an exchange of information on technical education is taking place. Papers have been issued in the form of a questionnaire dealing with accident prevention and safety in industry generally, and it is hoped to begin collecting information on a comparable basis from January 1, 1957. The International Council was represented at a conference held in Vienna in September, at which the interesting subject of inter-firm comparisons was discussed. This conference was sponsored by the European Productivity Agency and its report will receive careful consideration by the International Council when it is published.

The steering committee noted an increase in world copper production in the first half of 1956 of nearly 10 per cent over production during the first half of 1955. Statistics of production of copper and copper alloy semi-finished products are by arrangement printed in the *Monthly Bulletin of the British Bureau of Non-Ferrous Metal Statistics*, the circulation of which is increasing in European countries. The lower price of copper now in evidence was welcomed and it was hoped that this factor, coupled with a greater degree of stability, would be the keynote of the future market in this commodity.

Proposals to create a free trade area in Europe have been briefly discussed and plans made for maintaining close contact between member countries over this complex and difficult problem.

Swedish Launches and Deliveries

A considerable number of ships were launched and delivered by Swedish shipyards during September, among vessels delivered being a combined cargo and passenger liner of 7400 tons, a large ore/oil carrier and a 19,300-ton bulk carrier. On September 27th, the Götaverken shipyard delivered the combined ore and oil carrier M.S. "Soya-Pacific" to the Rederi AB Soya, of Stockholm. The ship has only two ore holds, but their dimensions are no less than 183ft by 33ft by 33ft, with a combined capacity of 377,000 cubic feet. The oil tanks, which are situated at the sides of and below the ore holds, have a volume of 808,000 cubic feet. The hatches are of Götaverken's hydraulically operated design, which can be opened and shut in a fraction of the time required for conventional hatches. A 10,000 i.h.p. Götaverken diesel gives the ship a loaded speed of 15 knots.

Kockums shipyard delivered the 19,300-ton bulk carrier M.S. "Biskopso" to Rederi AB Rex, Stockholm, on September 14th. This ship, which is the second in a new series, will, like her sister ship "Cassiopeia," be used for ore transport between Labrador and the U.S. East Coast, and as a coal freighter between the U.S. and Europe. The ship is also to be used as a school for eight officer apprentices. The main engine consists of a Kockum-M.A.N. eight-cylinder diesel, developing 7200 i.h.p. and giving a speed of 15½ knots. The same yard launched on September 11th the 13,500-ton d.w. closed shelter decker M.S. "Northern Clipper" for Rederi AB Clipper, of Malmö. The ship, which is scheduled for delivery in December this year, will be the largest motor cargo liner in the Swedish merchant fleet.

The Eriksberg shipyard on September 22nd delivered another combined cargo and passenger liner to the Swedish Transatlantic Company. It was the 7400-ton M.S. "Indiana," intended for the line's North America run. The ship is equipped with comfortable accommodation for a limited number of passengers. There are nine single cabins and one double cabin, all with bathrooms. The officers' and crew's quarters are also of a high standard. Most of the crew are quartered in single cabins. The propelling machinery consists of an Eriksberg-built six-cylinder Burmeister and Wain engine developing 8300 i.h.p. and giving the ship a speed of 17½ knots. The "Indiana" is Eriksberg's second delivery to Transatlantic this year. In all, the yard has delivered to this Swedish line twenty vessels aggregating 137,000 tons d.w.

On September 14th, Eriksberg launched a sister ship of the "Norefjell," which left the same berth on August 25th. The new vessel, the 4500-ton refrigerator ship M.S. "Björgstein," is building for A/S Hakedal and Hjalmar Björge, Oslo. Contracted service speed will be 17½ knots.

The Uddevallavarvet delivered in September the second refrigerator ship in a series of three ordered by the Thordén Shipping Line. The vessel, M.S. "Aase Thordén," is of 3500 tons d.w., and has a refrigerated capacity of 220,000 cubic feet. Her speed is 18¾ knots. The vessel is mainly intended as a fruit carrier, and her refrigeration machinery is designed to give very quick cooling down to 12–5 deg. Fah., but is also capable of freezing down to zero. The "Aase Thordén" is propelled by a ten-cylinder, two-stroke, single-acting engine of Götaverken design and made by Uddevallavarvet. It develops 6250 s.h.p. at 125 r.p.m. The engine is adapted for heavy oil fuel.

The Oresundsvarvet on September 18 launched the 4000-ton freighter "Arabritt" for A.R. Appelqvist AB, Stockholm. She is intended for bulk freights of ore and coal and is characterised as an "easy-trimmer."

Automatic Train Graphs

Among traffic control devices developed by the L. M. Ericsson Company, Stockholm, in recent years is a piece of equipment for the automatic graphic recording of train movements. Intended chiefly as a complement to centralised traffic control systems, it is reported to incorporate a number of novel ideas designed to simplify the control and increase the safety of railway and underground traffic.

The operator of a centralised traffic control system (C.T.C.) requires not only the visual picture of the current positions of trains, but also continuous recordings of train movements. Recordings by hand would be impracticable, nor would they give the clear graphic picture that is needed. By means of the L. M. Ericsson "Traingraph" a clear printed diagram is obtained, which gives a picture of the traffic for the hours immediately before and after the train movement. Different colours can be used for different tracks or different direction of movement. Another novel feature is the large capacity in relation to size of apparatus—permitting the connection of a maximum of 112 or 224 train passage transmitting devices.

The "Traingraph" instrument, which can be automatically operated on the data normally

received in a C.T.C. office, consists of an aluminium frame in which are mounted rolls, magazines and feed mechanism for the chart, electromagnetic stamps and arrangements for feeding the colour ribbons and changing from one colour to another. Moreover, it includes an impulse generator and one or more relay sets. The dimensions of the equipment (which can be installed in the operator's desk) are : length, 660mm ; width, 640mm ; height, 182mm ; the width of the chart being 352mm.

If the chart is preprinted with a graphic diagram of movements in conformity with the timetable the stampings will directly show whether trains are following the timetable and the extent of deviation from it. Written notes—which can be easily made on the chart—of train numbers will only be required in the event of abnormal delays. The putting on of extra trains is facilitated, as also notes regarding train cancellations.

The use of a "Traingraph" is not confined to the recording of train movements in conjunction with C.T.C. It can also be used for recording the passage of trains through single or a number of consecutive stations, provided that there is a device that can give a remote indication of the passage of trains.

Dechema Annual Report for the Year 1955

The annual report for 1955 of the Deutsche Gesellschaft für Chemisches Apparatewesen, Frankfurt-on-Main, was published recently. The first section records details of the many lectures and meetings that were organised or sponsored by the Dechema during the year. References are also made to the two technical journals published under the auspices of Dechema viz., *Chemie-Ingenieur-Technik* and *Werkstoffe und Korrosion* ; the Dechema Monograph series ; the "Erfahrungsaustausch" series and the other publications of the Society. A sum totalling approximately DM.200,000 was expended during the year 1955 for purposes of scientific research. This sum included grants made from the Max Büchner Foundation, which is managed by the Dechema.

The section dealing with the activities of the Dechema-Institut für Apparate-und Stoffkunde shows that the work of this institute, which is solely of a documentary nature in the chemical apparatus and equipment field, is developing along sound lines and is making a valuable contribution to the rationalisation of intellectual activity in this field.

Another section of this annual report contains the final summary of results of the Achema XI Chemical Apparatus and Equipment Congress and Exhibition, which, it will be remembered, was held in Frankfurt-on-Main from May 14 to 22, 1955. A review of the activities of the Max Büchner Foundation, which is managed on an honorary basis by the Dechema, shows that no less than fifteen research projects have been financed by the Foundation, to the extent of DM.55,110. The results of these projects are detailed at length in this section.

The report closes with a description of the First Congress of the European Federation for Chemical Engineering, which was held in 1955. Also included is an index of DIN standards which have been drawn up with the co-operation of the Dechema.

Extension Plans for Swedish Forest Industries

The Swedish pulp and wallboard industry is planning far-reaching extensions, according to a report published by the South Swedish Forest Industry Investigation Committee. By 1960 the volume of production of the pulp industry will exceed that of 1954 by about 47 per cent, or by about 1,700,000 tons, if the present plans are carried through. In the corresponding period the capacity of the wallboard industry should be increased by about 300,000 tons, or 80 per cent.

The committee expects, however, that it will be difficult to realise these plans in the next four to five years, partly because of raw material problems. It therefore considers it realistic to reckon it will take about ten years to carry through the present projects. On a somewhat longer view the committee judges the raw material situation to be favourable.

The annual quantities of timber available for lumbering in Central and South Sweden are estimated to increase up to the middle of the 1980s by an average of about 30 per cent for large dimensions and by about 3 per cent for smaller dimensions. At the same time the possibilities of obtaining raw material from the North Swedish forests will remain at any rate unchanged. In addition, new techniques are making it increasingly possible to utilise small timber, hard wood and sawmill waste. The use of pinewood for the production of sulphite pulp is also stressed. As the supply of timber in North Sweden has been found to be considerably better than indicated by previous inventories, earlier projects of "importing" South Swedish timber to the processing mills in the northern part of the country are no longer of urgent interest, according to the Committee.

Slag Heap Reclamation in Upper Silesia

One of the main tasks in the Economic Plan of the Upper Silesian industrial district is stated to be the exploitation of pit heaps. The heaps constitute large sources of valuable raw materials and can play a considerable role in supplying numerous branches of the national economy.

Pit heaps in Silesia are estimated to total over 80,000,000 cubic metres and cover an area of over 1000 hectares.

Preliminary research has shown that 10 per cent of the millions of tons of coal dumped on the heaps as a waste product in coal sorting and washing plants could be reclaimed. Carbonaceous slates reclaimed from the pit heaps and used as an admixture to clay will enable the building ceramic industry to improve the quality of bricks. The production of cement is based to a large extent on the use of coal slag, of which there are great quantities in the Silesian pit heaps.

It is also planned to use the material from slag heaps for the production of prefabricated building elements, for the construction of roads and as a gobbing material to fill worked-out sections of mines.

With the help of an electromagnet and by other means, considerable quantities of scrap iron can be gathered from enormous heaps of waste near the Kosciuszko, Pokoj, Florian, Bobrek and other iron and steel works, which resulted from the primitive smelting methods formerly employed there.

Iron-separating installations are already being introduced in many Polish works. Efforts are also being made by the iron and steel industry to prevent the further growth of waste heaps by handing over the slag from current production for immediate use.

Self-Tensioning Belt Drive

We have received details of a self-tensioning belt drive manufactured by Leder and Cie., Ltd., Rapperswil, Switzerland. In this design the driving shaft bearings are mounted eccentrically in relation to the pulley centre line, so that the centre distance of the two pulleys is varied by the driving shaft swinging about this eccentricity. The shaft is arranged so that the torque developed will tighten the belt. Two realisations of this principle are available. In the first, the driving pulley is mounted directly on the motor shaft and the motor itself swings about the eccentricity. In the second version, the motor is stationary, and the motor pulley is mounted on a bracket or arm which can rotate about the motor shaft as centre, the drive to the pulley being by means of gears. In this case, therefore, a speed reduction can be effected. It is claimed for the "Sespa" drive that belt slip is greatly reduced with ordinary extensible belts, and even more so with inextensible belts, and that efficient drives are obtained with angles of contact of only 90 deg., or even less than 75 deg. This makes it possible to construct belt drives combining a large ratio with a short centre distance of the pulleys. At the same time, it is claimed, driving power is saved due to the fact that the belt tension varies with the torque transmitted, i.e. with the load if the speed is constant. The agent in the U.K. is Sespa, U.K., Ltd., 243, Church Road, Mitcham, Surrey.

German Super Tankers

It is announced that Esso Tankschiff Reederei G.m.b.H., Hamburg, has placed orders for ten super tankers for its own fleet to be completed by the end of 1961, the total tonnage involved being 430,000 tons deadweight Of a recent order for nine 36,000-ton tankers, six units have meanwhile been changed to 46,000 tons deadweight, and another 46,000-ton ship has been newly ordered.

The new 46,000-ton tankers are to have a length of 225m, a fully-laden draught of 11·28m (37ft) and a speed of 17 knots. All orders for this programme went to German yards. The Deutsche Werft, Hamberg, is to build the three 36,000-ton ships, while of the seven 46,000-ton tankers, Howaldtswerke (Hamburg) will build four, A. G. Weser (Bremen) two, and Kieler Howaldtswerke, one.

Including the turbine-driven tanker "Esso München" of 26,650 tons deadweight which was recently put into service, Esso Tankschiff Reederei, G.m.b.H. now owns a fleet of 137,000 tons deadweight. Besides foreign tankers, the company operates the greater part of German tanker tonnage under medium or long-term charter, so that its total share of the German tanker tonnage is at present about two-thirds.

German Industrial Electricity Production

Last year the German Federal Republic produced a total of 76,500 million kWh of electricity, compared with 68,520 million kWh in 1954. Of this output, industrial power generation accounted for 29,130 million kWh (26,420 million kWh in 1954). Industrial power stations thus accounted for 38·1 per cent of the total generation (38·6 per cent in 1954). Most of the industrial power (about 73 per cent) was generated in Nordrhein-Westfalen. This land includes some of the most heavily industrialised areas, such as the Ruhr district. Industrial electricity production there amounted to 21,300 million kWh last year, compared with 21,200 million kWh generated by public supply companies. Of the 21,300 million kWh, 81 per cent was produced by coal mines, chemical works, the petroleum industry, and the iron and steel industry. About 23 per cent of the output, i.e. 6760 million kWh, was supplied to the grid, as compared with 6000 million kWh the year before.

German Commercial Vehicle Plant

A Volkswagen commercial vehicle factory has recently come into production in Hanover. The works at present produce a daily total of 230 delivery vans and special-purpose trucks. It is anticipated that all commercial vehicle production will be transferred from the Wolfsburg factory to the new plant, while Wolfsburg will entirely be devoted to the manufacture of private cars.

The commercial vehicle factory is stated to occupy 120,000 square metres of ground, and its construction is said to have required 9,000,000 man-hours at a cost of DM.125 million. Some 2000 construction workers were engaged. The plant is thus three times as big as the truck division at Wolfsburg. Much of the production and testing is carried out completely automatically. It is hoped to reach full production by the end of the year, with an output of 300 vehicles a day.

German Standards in Translation

The German Standards Institute (DNA), Berlin, W.15, Uhlandstrasse 175, has available a collection of translations of some 670 German standards into English, French, and Spanish. As the cost of translation is very high, the Institute in the main has to rely on existing translations made by individual firms and organisations. The Institute would be interested to obtain such translations of further German standards with a view to their publication.

The American Scene

BY OUR AMERICAN EDITOR

DEVELOPMENTS IN MAGNESIUM

THE youthful American magnesium industry recently took considerable pride in the fact that the metal was selected for the fabrication of the artificial earth satellite spheres. After a decade of intensive spadework, magnesium, which was used widely for the first time in the United States during World War II, now seems to be carving out a niche in the civilian market. At the present time, the Dow Chemical Company is the country's sole primary producer. However, plans for the formation of a second firm, the Alabama Metallurgical Corporation, recently were announced. This is to be a joint venture by Brooks and Perkins, Incorporated, with a magnesium fabrication works in Detroit, and Dominion Magnesium, Ltd., a Canadian producer of high-purity metal under its own patented process. The Alabama Metallurgical Corporation intends to build a works with a rated annual capacity of 10,000 tons. The new facilities, which will make use of the Dominion ferro-silicon process, are expected to come into production next year. Dow, too, is boosting its capacity by 10 per cent at one of its two works in Texas. Even now, output is on the rise. In the first half of 1956, American shipments of magnesium castings totalled 9049 tons, a rise of 25 per cent over the comparable figure a year ago. The total magnesium output this year may reach 70,000 tons, up nearly 15 per cent from 1955. What is perhaps more significant, for the second successive year, civilian use of the metal is likely to exceed that of the military. At the present rate of growth, consumption will catch up to American production capacity in eighteen to twenty-four months. Finally, as further evidence of the growing ability of magnesium to stand on its own feet, Dow has increased the price twice during 1956, to a current level of 35¼ cents a pound.

Prior to the last war, magnesium was produced on a small scale in the United States by the Dow Chemical Company from its Michigan salt brines. Production remained negligible through the 'thirties, and did not assume sizeable proportions until World War II. Output then soared to a peak of 185,000 tons in 1943, reflecting the heavy wartime demand for the light metal in aircraft construction. But as military consumption slackened after the war, output dropped sharply; fewer than 50,000 tons were produced in 1945 and only 13,000 tons in the following two years. With the outbreak of the Korean War and the accompanying Government stockpiling programme, demand from the services revived. Production rose to 23,000 tons in 1950 and jumped to more than 105,000 tons two years later, when about 75 per cent of the total was used in fabricating items for defence. As stockpiling then tapered off, so did magnesium output—to a four-year low of 61,300 tons last year. But in 1955, for the first time, civilian use of magnesium accounted for more than half of all consumption. The metal long has had the potential to challenge both aluminium and copper. Pound for pound, it is considerably cheaper than either, since it is only 60 per cent as heavy as aluminium, which, in turn, weighs little more than one-quarter as much as copper. Partially offsetting these advantages are the high fabricating costs, poor corrosion resistance and susceptibility to stress of magnesium. Much progress, however, has been made in overcoming these drawbacks through advances in the art of fabrication. Magnesium then, is a "natural" wherever lightness is essential. Furthermore, magnesium is used as a chemical as well as a metal. The fast-growing American titanium industry currently consumes about 10,000 tons of magnesium annually, much of it for the reduction of titanium tetrachloride. The reduction of zirconium also requires high-purity magnesium. The commercial uses of magnesium are as diverse as the military. Even though the total tonnage required is still relatively small, the rate of growth is accelerating. The use of magnesium photo-engraving plates, for example, has doubled in the past year. Sales of magnesium luggage have risen substantially since its introduction little more than twelve months ago. Die-castings of the metal are gaining in popularity, and truck bodies made of it began rolling off the assembly lines for the first time in 1955. Sales to the aluminium industry, which uses magnesium as an alloying element, are on the rise, as are shipments of magnesium anodes for the protection of steel structures.

Besides Dow's facilities, six Government-owned magnesium works—in Ohio, Connecticut, California, Washington and New York—have been built. All but one of these were reactivated in 1951 to meet stockpiling needs, but most of this capacity was shut down again with the end of that wartime programme. Government-owned facilities at Canaan, Connecticut, still produce high-purity metal for the Atomic Energy Commission, but for practical purposes Dow to-day is the sole domestic producer. Although both are relatively new enterprises, the backers of the proposed Alabama Metallurgical magnesium venture are no strangers to the business or to each other. Deep-drawn magnesium stampings and assemblies are produced by Brooks and Perkins in a wide range of products. Besides magnesium components for bombers and missiles, the company is fabricating titanium for use in aircraft. It also processes zirconium into atomic reactor parts. Its fabricating facilities at Detroit have been supplemented recently with a new magnesium rolling mill at Livonia, Michigan. Dominion Magnesium, Ltd., for its part, opened Canada's largest and most modern magnesium foundry at Haley, Ontario, late in 1952. The firm originally was organised in 1941, following the invention by Dr. Lloyd M. Pidgeon of a new way of producing the metal. His ferro-silicon process is based on the use of silicon as a reducing agent, and the principal raw material is dolomite rock, which is plentiful throughout North America. In contrast to the Dow electrolytic method, which uses electrical energy to separate chlorine from the magnesium, with salt water being the principal raw material, the Pidgeon process uses heat to separate oxygen from the magnesium. The ferro-silicon process is believed to cost more than the Dow process, but it produces purer metals. The proposed plant of the Alabama Metallurgical Corporation will draw upon the large local dolomite rock reserves, and will use natural gas as a heat source. Initially the dolomite will be quarried in an open pit operation at Montevallo, 75 miles from the reduction works. It will be crushed and burned in a conventional rotating kiln. The burned dolomite, or calcine, is ground, and mixed with ground ferro-silicon, FeSi, which is a reducing agent. The mixture is briquetted into pellets elliptical in cross section. These pellets, or briquettes, are placed in a retort, the air is exhausted, and heat is applied in a suitable furnace. At the proper temperature of about 2100 deg. Fah., the oxygen goes from the magnesium oxide to the silicon, freeing the magnesium in a gaseous state. The magnesium vapour, of very high purity, flows toward the cooler end of the retort, and condenses out, forming a rather dense mass of pure magnesium crystals which is removed periodically. The retorts are cylindrical and are made of high alloy iron, with one end closed, and a removable water-cooled condensing head fitted to the other end. The crystalline mass, referred to as a "crown," is removed from the condenser and is then melted by conventional methods and poured into ingots of suitable size. Brooks and Perkins will take part of the new company's output to fill certain of its magnesium requirements; it now imports high-purity magnesium from Canada at a cost of more than 50 cents a pound, although the bulk of its requirements is obtained from the Dow Chemical Company. It is fortunate for the American engineering industry to be able to depend on two rather than a single source of magnesium shortly, and such competition is likely to lead to accelerated progress in the development of greater application of the metal. The Dow concern has been a true pioneer in many phases of magnesium production and fabrication and deserves particular praise for planning its new rolling mill at Madison, Illinois, on a truly ambitious and advanced level, knowing full well that this progressive approach would initially lead to considerable financial sacrifice. Losses at Madison, though still heavy, have now been reduced substantially, and with an increasing civilian market the works may soon be self-supporting.

U.S. Navy Shipbuilding Programme

SINCE its acceleration at the start of the Korean war, the shipbuilding programme of the U.S. Navy has continued on a considerable basis. The 1271 vessels ordered in the year ended July 31, 1956, have a contract value in excess of 1,135,000,000 dollars. In addition, large sums have been and are still being expended on the conversion, alteration and modernisation of existing combat and auxiliary craft laid up in the "mothball" fleet or in operation. Outstanding among last year's new contracts was the 60,000-ton aircraft carrier of the "Forrestal" class ordered from the New York Shipbuilding Corporation, Camden, New Jersey. This is the fifth vessel ordered, two having been placed with the Newport News Shipbuilding and Dry Dock Company and two with the New York Naval Shipyard. Incidental to the ordering of this fifth aircraft carrier is the current construction of a 1200ft long graving dock at the Camden shipyard in which the carrier will be built. Newport News completed one carrier, the U.S.S. "Forrestal," in 1955, and the U.S.S. "Saratoga" was delivered recently by the New York Naval Shipyard and was commissioned as illustrated here. The keel for the

60,000-ton aircraft carrier U.S.S. "Saratoga" being commissioned at the New York Naval Shipyard in Brooklyn

third carrier, the U.S.S. "Ranger," was laid at Newport News on August 2, 1954, and the vessel was launched on September 29, 1956. The keel for the fourth carrier, the "Independence," was laid at the Brooklyn yard on July 1, 1955. The fifth carrier will be named "Kitty Hawk."

Other important contracts placed during the last twelve months include seven destroyers (DD), three frigates (DL), two destroyer escorts (DE), and seven submarines. Of the latter, four will be nuclear-propelled. In addition, many landing craft of various types and sizes were ordered. The Defence Department Appropriation Act provides the sum of 1,479,700,000 dollars of new money to cover the 1957 naval shipbuilding and conversion programme, and certain additional funds needed for earlier programmes. This is 92,066,000 dollars more than was made available for the 1956 fiscal programme. A total of 306 new vessels are to be constructed in the fiscal 1957 programme. For this purpose there has been appropriated 1,108,269,000 dollars. Included in this sum is 22,000,000 dollars to cover the cost of design of a nuclear reactor for a "CVA" aircraft carrier of the "Forrestal" class. While this new carrier is not provided for in the fiscal 1957 programme, the U.S. Navy has been authorised to commence design and advance procurement for a nuclear-powered aircraft carrier. Most prominent in the new shipbuilding programme is the sixth aircraft carrier of the "Forrestal" type. Of the remainder, twenty-two of the new ships will be major units and the balance of 283 will be various landing craft and service vessels. The modernisation and alteration programme includes four large aircraft carriers, five light cruisers, one submarine, and thirteen auxiliary vessels.

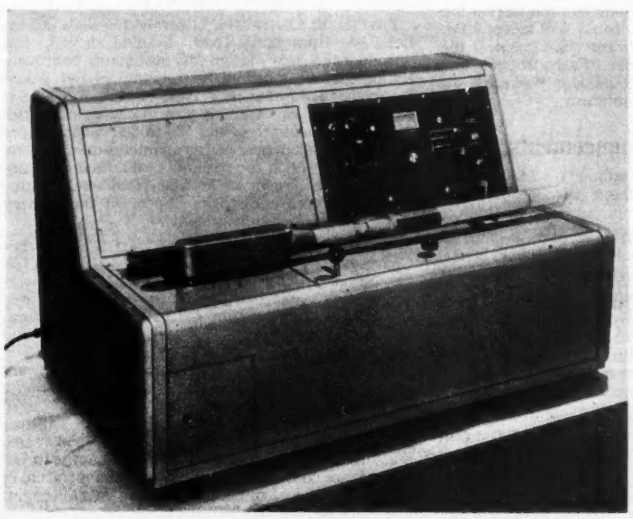
The nuclear-powered light cruiser in the 1957 shipbuilding programme, which was awarded to the Bethlehem Steel Company's Quincy yard, is the first U.S. Navy surface ship designed to utilise nuclear propulsion. In addition, this vessel will be the first guided-missile cruiser built from the keel up. From the knowledge gained in the design and construction of this vessel, its machinery and weapons, the U.S. Navy will be able to develop other large vessels envisaged for future needs. This vessel represents an intermediate development in nuclear-propulsion design between the relatively small installation in the highly successful submarine, U.S.S. "Nautilus" and the very complex installation planned for a large aircraft carrier. In line with the increasing emphasis on guided missiles in all the Armed Forces, the 1957 shipbuilding programme authorises the construction of four guided-missile frigates and eight guided-missile destroyers. These vessels, together with the cruiser and destroyer-conversions being completed, will form the nucleus of modern escort ships required to accompany the task forces of the future and provide protection against enemy aircraft and submarines.

The six nuclear-powered submarines, together with the absence of conventionally propelled submarines in the 1957 shipbuilding programme, attest to the success of the U.S.S. "Nautilus" and to the advances which have been made in submarine design. In a relatively short time, it is planned that nuclear submarines will comprise the bulk of America's active submarine forces. The two destroyer-escort vessels in the 1957 programme are part of the U.S. Navy's continuing efforts to build newer types of escort vessels to meet the ever-increasing submarine threat to the free world. This is a long-range programme necessary to meet the acute threat of block obsolescence in this class of vessels.

Instrument for the Calibration of Torque Wrenches

THE accompanying illustration shows a calibration tester which was recently designed and built by the Electronics and Instrumentation Division of the Baldwin-Lima-Hamilton Corporation, Cambridge, Massachusetts, for checking torque wrenches used on aircraft. Other devices can be calibrated with minor modifications of the tester. The instrument is portable, is designed to maintain its accuracy through a wide temperature range, and to cover a wide range of torque testing capacity. There are no moving parts, knife edges, mechanical linkages, or friction devices, and therefore maintenance is insignificant and accuracy is not impaired with use. Torque is sensed by small interchangeable torque pick-ups on which "SR-4" resistance wire strain gauges are bonded.

The torque measuring system consists of an electronic amplifier and an indicating instrument with rotating dial on which torque can be read in inch-pounds: 1in-lb per division up to 2040in-lb and 5in-lb per division up to 6200in-lb. The low range is provided in five steps of 440 divisions each and the high range in three steps of 440 divisions each. Separate torque pick-ups are used for the two ranges. Loads are applied on the handles of torque wrenches hydraulically through an adjustable fulcrum and the tester is powered by plugging into a 115V, 60 c/s electric line. The pick-up cells are provided with hexagon, square and special adapters. Storage space is provided in the tester cabinet for accessories. The operating controls of the instrument include a loading knob, a range selector switch, and a load step switch to utilise the 440-division indicator scale on different sections of the full scales to 2040in-lb and 6200in-lb. The tester itself can be calibrated readily by means of a calibration arm and dead weights.



Testing instrument for calibrating torque wrenches

Engineering Societies Centre to Remain in New York

THE presidents of the American Society of Civil Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Institute of Chemical Engineers, announced recently that they have received the report of the "Special Task Committee of Fifteen" appointed to make recommendations with regard to the site of the Engineering Societies Centre, and action is now being taken by the several governing boards. The recommendations were as follows:—(1) The Engineering Societies Centre be located in New York City. (2) the 39th–40th Street site be continued in use as the site of the Engineering Societies Centre. If rebuilding in that area proves impracticable, a comparable site should then be sought in mid-town New York. (3) The United Engineering Trustees, Incorporated, be authorised to take proper legal action for expansion by the addition of the American Institute of Chemical Engineers to the incorporators when properly qualified. (4) The United Engineering Trustees be authorised to raise money and accept contributions; let contracts for the reconstruction of the present Engineering Societies building and/or a new building or buildings, and operate and maintain the new Engineering Societies Centre. (5) The plans for the new and enlarged Engineering Societies Centre be made with ample optimism with respect to the future growth of the five societies immediately involved. These facilities should be such as to attract and hold all of the engineering profession, thus fostering unity and co-operation along broad lines. Thus, after considerable efforts by interests representing other American cities, including Chicago, Pittsburgh and Washington, a decision has finally been made by the senior American engineering institutions to have their joint headquarters remain in New York City.

Personal and Business

Appointments

MR. BILL BEDFORD has been appointed chief test pilot of Hawker Aircraft, Ltd.

MR. R. B. LONG has been appointed export sales manager of Chaseside Engineering Company, Ltd.

SIMMS MOTOR UNITS, Ltd., announces the appointment of Mr. J. Bell as manager of its Cardiff branch.

MR. J. B. LONGMUIR has been appointed Scottish regional manager of Megator Pumps and Compressors, Ltd.

MR. S. L. POTTER has been appointed commercial manager of the Dunlop Wheel and Rim Company, Ltd., Coventry.

CAPTAIN F. S. BELL, R.N. ret., has taken up an executive appointment with Pollard Bearings, Ltd., Ferrybridge, Yorks.

MR. ALFRED BOWLT has been appointed chief buyer of Guest Keen Iron and Steel Company, Ltd., in succession to the late Mr. A. S. Davies.

NORRIS, HENTY AND GARDNERS, Ltd., states that Mr. L. G. Stockwell, A.M.I.Mech.E., has been appointed London regional service manager.

MR. M. B. HENDERSON and Major General Sir John Sinclair have been elected to the board of The Universal Asbestos Manufacturing Company, Ltd.

MR. J. W. SIMPSON, secretary of the British Electrical Power Convention, has been elected chairman of the newly formed Institute of Conference Management.

MR. G. J. INNES, Dr. J. B. Mavor, and Dr. A. S. MacLellan have been elected honorary members of the Institution of Engineers and Shipbuilders in Scotland.

DOULTON INDUSTRIAL PORCELAINS, Ltd., Doulton House, Albert Embankment, London, S.E.1, states that Mr. M. C. Blythe, M.I.E.E., has been appointed sales director.

BRITISH OXYGEN GASES, Ltd., has announced the appointment of Mr. G. Sims-Davies as equipment manager. Mr. Robert Fannon has been appointed his assistant.

BROOK MOTORS, Ltd., Empress Works, Sheffield, announces the following appointments to its sales engineering staff: Mr. C. T. Hinchliffe (Bristol), and Mr. W. B. Knowles (London).

THE BRITISH TRANSPORT COMMISSION has nominated Mr. J. C. L. Train, M.I.C.E., and Mr. T. H. Hollingworth to be members of the Coastal Shipping Advisory Committee, set up under the Transport Act, 1947.

MR. P. L. JONES, a director of Swan Hunter and Wigham Richardson, Ltd., has been re-elected chairman of the National Association of Marine Engine-builders. Mr. J. Ferrier, chairman and managing director of Rankin and Blackmore, Ltd., has been re-elected vice-chairman.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., states that Mr. J. S. E. Riddle has been appointed as its representative in Calcutta. He succeeds Mr. N. R. Hodges, who has now completed his term of overseas service and who has returned to this country.

DR. H. M. WILSON has been appointed deputy director-general of aircraft equipment research in the Ministry of Supply. Dr. S. Jones will succeed Dr. Wilson as head of the armament department at the Royal Aircraft Establishment, Farnborough, and Mr. N. Coles has been appointed deputy director, air armament research and development.

Business Announcements

VICKERS-ARMSTRONGS (AIRCRAFT), Ltd., Weybridge, states that its telephone number has been changed to Weybridge 5555.

SQUARE D, Ltd., has opened a branch office at 72a, Queen's College Chambers, Paradise Street, Birmingham (telephone, Midland 4212).

WICKMAN, Ltd., has recently completed a new office block for its "Wimet" division at the main works at Torrington Avenue, Coventry.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has announced the retirement of Mr. Ernest Thompson from its London district sales staff.

THE NATIONAL COUNCIL FOR TECHNOLOGICAL AWARDS now has its own premises at 9, Cavendish Square, London, W.1 (telephone, Museum 1978).

LUMENATED CEILINGS, Ltd., states that it is now represented in the N.E. area by the parent company, Thermotank, Ltd., Tyneside Works, Bede Trading Estate, Jarrow-on-Tyne.

MATTHEWS AND YATES, Ltd., Swinton, Manchester, has moved its Birmingham office to County Chambers, Corporation Street, Birmingham, 2 (telephone, Central 1089).

BENNIS COMBUSTION, Ltd., Little Hulton, Bolton, is now represented in Scotland by Engineering Agencies, Atholl Works, Rumblingwell, Dunfermline (telephone, Dunfermline 1677).

BABCOCK AND WILCOX, Ltd., is now established at its new headquarters, Babcock House, 209, Euston Road, London, N.W.1 (telephone, Euston 4321; telegrams, Babcock, London, N.W.1.)

FERRANTI, Ltd., Hollinwood, Lancs, states that, following discussions with the North of Scotland Hydro-Electric Board, it will shortly manufacture distribution transformers in Inverness.

THE BALLAST, SAND AND ALLIED TRADES ASSOCIATION will be known in future as the Sand and Gravel Association of Great Britain. Its address is 48, Park Street, London, W.1 (telephone, Grosvenor 8967).

THE UNIVERSAL ASBESTOS MANUFACTURING COMPANY, Ltd., has announced the retirement from the board of Mr. Robert Walker, technical director. Mr. Walker will continue to serve the company as a technical consultant.

OUGREE STEEL TRADING COMPANY, Ltd., will in future operate under the title United Continental Steels, Ltd. This company, whose address is Stone House, Bishopsgate, London, E.C.2, is the sole selling agent in London for the Belgian group formed by the merger between S.A. John Cockerill and Société d'Ougrée-Marihaye.

MONO PUMPS, Ltd., 1, Sekforde Street, London, E.C.1, has formed a subsidiary company in South Africa entitled Mono Pumps (Africa) (Pty.), Ltd. Mr. H. B. Hichens, M.I.Mech.E., is the chairman, and Mr. A. Taylor is managing director. The company is to open a factory in the Johannesburg district. Mono Pumps, Ltd., also states that its Australian branch has established a factory in the suburbs of Melbourne.

Contracts

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received an order valued at £550,000 from the East Midlands Division of the Central Electricity Authority for 275kV switchgear at the new High Marnham Generating Station, where the 200MW turbo-alternators will be connected directly to the super-grid through step-up transformers. The order includes nine 275kV lenticular-tank oil circuit breakers, which will control two generator-transformer units, two station transformers, three feeders, a busbar coupler, and a bus section.

Miscellanea

DISCUSSION ON DEGREASING.—The Metallurgical Engineering Committee of the Institute of Metals is arranging for an all-day informal discussion on "Degreasing," to be held at the University, Edgbaston, Birmingham, on Wednesday, February 27, 1957. The meeting will be open to both members and non-members of the Institute. Members and non-members who would like to be present should notify the Institute of Metals, 17, Belgrave Square, London, S.W.1, as early as possible.

PNEUMATIC CONVEYING EQUIPMENT.—Blaw Knox, Ltd., 94, Brompton Road, London, S.W.3, has introduced a new design of pneumatic conveying equipment for powders, fine granular and flaked materials. Known as the "Auto-Airflow" system, it is supplied in two sizes to give discharge capacities of 200 to 250 cubic feet and 600 to 800 cubic feet per hour. The system operates on an intermittent blowing principle by which the material is fluidised and conveyed in small aerated batches from an activator device fed from a receiving hopper to the delivery point through a flexible pipeline.

CORRECTION.—In our article "Trials of Turbo-Charged Two-Stroke Marine Diesel Engine" (THE ENGINEER, August 17, 1956, page 245) it was erroneously stated that non-return valves were fitted between the compression spaces under the pistons and the scavenge ports. This is not the case, and the second sentence of paragraph two, page 246, should therefore read: "During the downward stroke each piston compresses the air in the space underneath it and delivers it to the air receiver so that when the scavenge ports are uncovered the air flows into the cylinders at a slightly increased pressure." We are also asked to state that the turbo-blowers are constructed for a gas inlet temperature of 400 deg. Cent. and run at 6800 r.p.m. when the engine is at full load, not 260-300 deg. Cent. and 6000 r.p.m., as stated in our article.

BESSEMER CENTENARY EXHIBITION.—An exhibition is being held at the Engineering Department of Cambridge University to commemorate the centenary of the Bessemer process. The exhibits include a selection of Bessemer steel specimens made between 1856 and 1859, modern examples of steel made at Workington by the Bessemer acid process, and a model of a Bessemer plant which has been lent for the occasion by the Science Museum. The exhibition will remain open until November 17th.

NATIONAL DIPLOMA IN AGRICULTURAL ENGINEERING.—The report on the sixth examination for the National Diploma in Agricultural Engineering has been issued by the examination board which is appointed by the Institution of British Agricultural Engineers. The report shows that forty-five candidates sat for the examination, and that twenty-seven were awarded the diploma, two with distinction. The Institution's Johnson medal, which is awarded to a candidate who reaches a particularly high standard in the examination, has been gained this year by Mr. C. de B. Codrington. In some general comments, the examination board says that the standard of the successful candidates was the highest yet attained, and reached the level of technical knowledge which it is the Institution's aim to encourage.

INDUSTRIAL FILMS.—"Hydraulic Systems" and "Diesel Engine Lubrication" are the titles of two new films produced by the Continental Associates of the Mobil Oil Company, Ltd., which were shown in London recently. "Hydraulic Systems," which was made mainly in France, opens with simple laboratory demonstrations illustrating how energy is transmitted by means of fluids under pressure. The working of many of the pumps and valves used in hydraulic systems is explained and attention is drawn to the special properties incorporated in hydraulic oils, in order that they may function correctly. "Diesel Engine Lubrication," which was made in Germany and adapted to U.K. practice, demonstrates the need for correct diesel engine lubrication and shows how the use of additive oils is capable of providing improved lubrication. Animated diagrams illustrate the principles of supercharging and there is also a sequence on fuel injection. Both films have English commentaries and are available in 16mm size.

SHOT CLEANING FOR HEAT EXCHANGER SURFACES.—The "Tornado" shot process for cleaning the surfaces in boilers or other forms of heat exchangers has been introduced into this country from Sweden by Keith Blackman, Ltd., Mill Mead Road, London, N.17. With this equipment a constant stream of shot is fed to the top of the heat exchanger installation and is distributed evenly over the cross-sectional area by means of spreaders. As the shot falls it ricochets from tube to tube and in striking the heating surfaces it breaks loose the deposits. From fifteen to twenty-five shot are dropped per second by the spreaders on each square foot of heating surface of the heat exchanger, and after cascading through the tubes, the shot is collected in the ash hopper and returned to the distributors by a pneumatic elevator. Light dust loosened by the shot is carried away with the flue gases of the boiler, whilst heavy pieces of deposit fall on to a separator screen where they are broken up by the shot before being pneumatically separated. It is stated that the equipment can be used at any time in a boiler installation and generally needs only to be operated for about twenty minutes each eight-hour shift.

ALUMINIUM FOR TRANSMISSION LINES.—A brochure with the title "Aluminium for Transmission Lines" has been published by the Aluminium Union, Ltd., John Adam Street, London, W.C.2. It has been prepared in collaboration with Aluminium Laboratories, Ltd., Kingston, Ontario, Canada. The brochure discusses the development of aluminium conductor steel reinforced and aluminium stranded conductors, the choice of conductor, the advantages of aluminium for transmission lines and then goes on to give details of the types of conductor. There are notes upon specifications, available sizes and design considerations, followed by examples of line calculations by the short and long line methods and directions for the use of the quick estimating charts. A chapter on loading conditions deals with mechanical considerations, ice and wind loads, and in the next chapter sag and tension calculations and charts are referred to. Resonant vibration dancing and cyclonic gyration are reviewed and types of construction illustrated, together with erection practices, while other illustrations give examples of accessories for the conductors. Copies are available from the Northern Aluminium Company, Ltd., Banbury, Oxon.

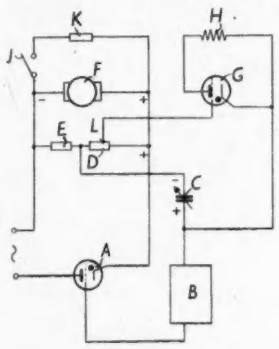
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

ELECTRICAL ENGINEERING

756,290. October 15, 1954.—ELECTRIC MOTOR CONTROL CIRCUITS, Philips Electrical Industries, Ltd., Spencer House, South Place, Finsbury, London, E.C.2. (*Communicated by N.V. Philips Gloulampenfabrieken, Emmasingel 29, Eindhoven, Holland.*)

For controlling motors electronically, as shown in the drawing, one or more grid controllers *A* are used, which are controlled through a phase-shifting device *B*. Control is effected by varying the control voltage at *C* by means of which the speed of the motor is adjusted. If it be assumed that in the



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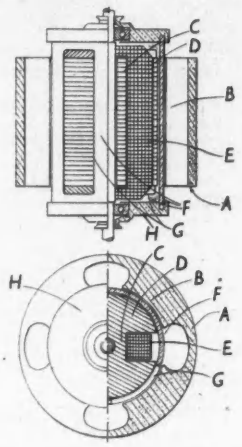
operating state, the control voltage at *C* is approximately 2V higher than the voltage across a resistance at *D* (which is part of a voltage divider *E* and *D*, connected in parallel with the motor *F*) in accordance with the invention, the algebraic sum of the voltages at *C* and across the resistance *D* is applied to the grid of a tube *G* in such a manner that normally the tube is cut off by the higher voltage at *C*. A supply arrangement is provided for the anode circuit of the tube *G*. With a decrease in voltage at *C*, the speed drops. Since, however, the motor has momentum, it induces a voltage corresponding to its speed, with the result that at the instant at which the control voltage at *C* decreases, the voltage at resistance *D* exceeds that at *C*. Consequently the grid of the tube *G* is driven positive, and the tube strikes, with the result that a relay *H* becomes energised, and its contact arm *J* is closed, so that the armature is connected to a load resistor *K* and the motor is braked. As soon as the voltage at *C* and across resistance *D* neutralise each other, the tube *G* is cut off, and causes disconnection of the resistor *K*. The braking operation occurs immediately when the control voltage at *C* drops below the part of the armature voltage appearing across the resistance *D*. Consequently the onset of braking does not depend upon extinction of the rectifier *A*. Overload due to braking while the rectifier is conducting cannot occur, since, as a rule, the current is automatically limited in discharge-tube-controlled motor drives. Often, however the additional requirement is imposed the braking action begins only if a considerable speed difference occurs between the actual motor speed and that corresponding to the value set by means of the control voltage at *C*. This is achieved by shifting the take-off contact *L* of the resistor *D*. In this manner the tube *G* only strikes if a correspondingly higher voltage appears across *D*.—*September* 5, 1956.

756,806. August 13, 1954.—ELECTRIC GENERATORS, Agustin Martinez Latorre, 236, c/X1, Rua Caetano Pinto, Sao Paulo, Brazil.

The object of the invention is to provide an electric generator comprising a rotor moving between the poles of the magnetic field of the magnet and the poles of the stator and absorbing the magnetic flux from the magnets; the internal or central parts of the generator remain stationary. Referring to the drawing, the generator comprises a shell *A*, with a permanent magnet having poles *B*; a stator *C* comprising laminated magnetic poles *D* and load coils *E* with windings of copper wire or similar material; a rotor *F*, with openings *G*, the rotor being made of bismuth, or alloys of bismuth, with any other non-magnetisable materials. The rotor *F*, placed between poles *B* and *D*, is attached to discs *H* of a similar non-magnetisable material. The rotor *F*, of tubular or cylindrical form, is provided with openings *G* on its outer face, which permit the passage of the magnetic flux from the magnetic fields of the magnet *A*, by means of poles *B*, to the stator *C* by means of poles *D* of the stator, concentrating



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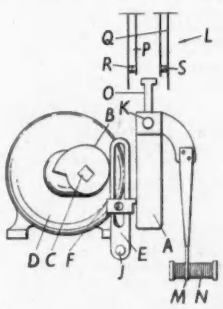
finally in the load coils *E*, the windings of which vary in accordance with the voltage required. Although in the drawings rotor *F* is shown as a cylindrical body, it will be understood that this form is not essential and that similar results can be obtained with rotors of circular or disc form, or any other appropriate form, providing the rotor is made from bismuth, bismuth alloys with any other non-magnetisable materials and having openings for the passage of the magnetic flux. An alternative design of rotor is also described in the specification.—*September* 12, 1956.

757,029. August 19, 1953.—CONTROL APPARATUS FOR ELECTRIC MOTORS, Frank Martin Hussey Taylor, Ph.D., B.Sc., 2-10, Valentine Place, Blackfriars, London, S.E.1.

The invention has reference to improvements in, and relating to, electrical control apparatus comprising a motor supplying the drive for the control operation, a potentiometer associated either with a control circuit for the motor or with a control circuit for another motor, and a cam driven by the first-



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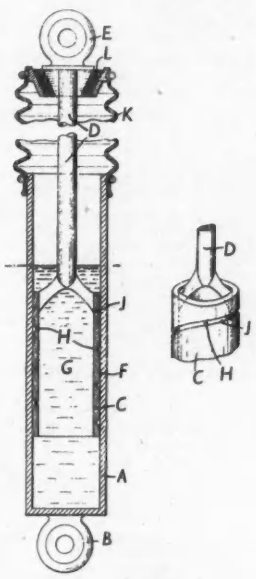
mentioned motor adapted to displace the wiper of the potentiometer. In the drawing, the pivoted arm *A* is opposite to and spaced from the profile of the cam *B*, the cam being on a shaft *C* driven by a motor *D* and in the space is located a rocker arm *E* substantially parallel to the pivoted arm *A*, the rocker arm carrying a tappet *F* which can be adjusted along the rocker arm whilst maintaining contact with a side of the pivoted arm. The pivoted arm *A* and the rocker arm *E* may be spring loaded to ensure contact with the tappet and cam. The rocker is pivoted at *J* to one side of a line passing through the camshaft and the point of contact of the cam with the rocker, whilst the pivot *K* of the pivoted arm is at the other side of the line. In the case of a motor control, the pivoted arm is designed to operate a limit switch *L* when the wiper arm *M* rigid with the arm *A* reaches either end of the potentiometer *N*. A convenient arrangement shown comprises a finger *O* rigid with the arm *A* and operating in a space between two contact-carrying arms *P* and *Q*, respectively associated with a corresponding contact *R* or *S*, the arrangement being such that the finger when at one extremity or the other of its sweep (corresponding to one extreme position or the other of the wiper) engages a contact-carrying arm and separates that pair of contacts. These conditions can be made to obtain by appropriate adjustment of the tappet whatever be the angular movement of the cam. The motor *D* drives the camshaft through a reduction gear; the camshaft operates the controller element through its own linkage.—*September* 12, 1956.

SHOCK ABSORBERS

758,310. November 10, 1954.—MEANS FOR SUPPRESSING VIBRATIONS, Societe D'Inventions Aeronautiques et Mecaniques S.I.A.M., 1, Route Des Alpes, Fribourg, Switzerland.

The invention provides a device for damping relative oscillation between two elements in a specific direction. Referring to the drawing, the cylindrical body *A* of the shock-absorber has a pivotal attachment at *B*, whereby it may be secured to, for example, the non-suspended part of a vehicle. Inside the



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body is a sliding sleeve *C* carried by a rod *D* having a ring *E* for securing it to the suspended portion of the vehicle. An annular space *F* of the order of a few hundredths of a millimetre—for example, 0·02mm to 0·06mm—is provided between the sliding sleeve and the cylinder, and this is filled with a liquid *G* having a viscosity of the order of 1000 to 30,000 centistokes up to a level above that which the sleeve can reach during its maximum travel towards the top of the cylinder. The liquid constantly supplies the annular clearance *F* through the orifices *H* to a spiral groove *J*. The upper portion of the rod *D* is protected against mud and dust by a bellows sheath *K* and the unit may be completed with advantage by an air-filter *L*.—*October* 3, 1956.

GAS TURBINES

758,399. May 13, 1954.—COMBUSTION PRODUCTS IN GAS TURBINE PLANTS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

According to the invention, a method of reducing harmful effects of combustion products in a gas turbine plant comprises adding to the fuel, or introducing into the flame or into the combustion products, an additional substance containing both kaolin and metallic aluminium. Care should be taken that the metallic aluminium does not contain as much as 1 per cent aluminium oxide as an impurity, since an oxide content of about 1 per cent Al_2O_3 can reduce the effectiveness of the additional substance. The relative proportions of kaolin and metallic aluminium in the additional substance can vary widely. For instance, proportions of from 10 parts to 100 parts by weight of kaolin to 1 part of metallic aluminium in the form of aluminium powder have proved suitable.—*October* 3, 1956.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Nov. 9th.—STOKE AND CREWE BRANCH: Grand Hotel, Hanley, Stoke, "Fluorescent Lighting," C. B. Styles, 7.30 p.m.

Mon., Nov. 12th.—N.W. LONDON BRANCH: Century Hotel, Forty Avenue, Wembley Park, "Modern Lighting," E. H. Maddox, 8.15 p.m.——CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, W.C.1, "Interplanetary Science and the Development of the Rocket," K. L. Ward, 7.30 p.m.

Tues., Nov. 13th.—JOINT MEETING WITH THE INSTITUTION OF ENGINEERS-IN-CHARGE: Magnet House, Kingsway, London, W.C.2, "Electronic Control of Industrial Drives," E. J. P. Long, 6.30 p.m.——BOURNEMOUTH BRANCH: Grand Hotel, Firvale Road, Bournemouth, "Lighting," R. T. O. Freeth, 8 p.m.

Wed., Nov. 14th.—GLASGOW BRANCH: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Fire Protection," A. Chadwick, 8 p.m.——HALIFAX BRANCH: Lentelfield House, Overden, Halifax, "Times and Seasons," J. G. Stirk, 7.30 p.m.

Thurs., Nov. 15th.—KENT BRANCH: Coniston Hotel, Sittingbourne, Film Show, 8 p.m.——SOUTHAMPTON BRANCH: Canute Room, Polygon Hotel, Southampton, "Transistors and their Applications," R. R. Betteridge, 8 p.m.

Sat., Nov. 17th.—N. LONDON BRANCH: Visit to Park Royal Brewery, Arthur Guinness Son and Co., Ltd., 2.15 p.m.——OXFORD, READING AND DISTRICTS BRANCH: Regents Park College, Pusey Street, Oxford, "The 13th Edition of the I.E.E. Rules," J. J. Looker, 6.30 p.m.

BELFAST ASSOCIATION OF ENGINEERS

Wed., Nov. 14th.—College of Technology, Belfast, "Nuclear Power Stations," G. F. Kennedy, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Nov. 14th.—W. MIDLANDS SECTION: Technical College, Wulfruna Street, Wolverhampton, "The Automatic Factory," J. A. Sargrove, 7.15 p.m.——N.E. SECTION: Neville Hall, Westgate Road, Newcastle upon Tyne, "Some Practical Aspects of Echo Sounding," A. M. Sutton, 6 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Nov. 12th.—SHEFFIELD CENTRE: Medical Library, The University, Western Bank, Sheffield, 10, "Trends in Interior Installations and Design," H. H. Ballin, 6.30 p.m.

Tues., Nov. 13th.—SESSIONAL MEETING: Federation of British Industries, 21, Tothill Street, London, S.W.1, "The Starting of Fluorescent Lamps," D. T. Waigh and L. C. Wiltshire, 6 p.m.

Thurs., Nov. 15th.—MANCHESTER CENTRE: N.W. Electricity Board, Town Hall, Manchester, "School Lighting, Part II," 6 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Nov. 12th.—DUNDEE BRANCH: Mathers Hotel, Dundee, "The Maintenance of Gas Turbine Aircraft Engines in the Royal Air Force," D. J. Hughes, 7.30 p.m.

Tues., Nov. 13th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Lubrication and Selection of Lubricants," G. Stott, 7.15 p.m.

Wed., Nov. 14th.—E. MIDLANDS BRANCH: County Hotel, Theatre Square, Nottingham, "Engineering Equipment in Modern Building," G. W. Glover, 7 p.m.——WESTERN BRANCH: Grand Hotel, Bristol, "Materials Handling," J. G. Parkes, 7.15 p.m.

Thurs., Nov. 15th.—BLACKBURN BRANCH: Golden Lion Hotel, Blackburn, "Smoke Abatement," J. D. Lewis, 7.30 p.m.

Wed., Nov. 21st.—KENT BRANCH: Kings Head Hotel, High Street, Rochester, "The Operation and Maintenance of Fuel Economisers," H. J. Gardner and M. R. Wagner, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Sat., Nov. 17th.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Broad Street, Bristol, 1, "Some Aspects of Modern Casting Design and Running Technique," R. W. Ruddle, 3 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Nov. 12th.—MERSEYSIDE AND N.W. SECTION: Old Swan Technical College, Liverpool, "Petroleum Refining," E. H. Wild, 7.30 p.m.

Tues., Nov. 13th.—85, Minories, London, E.C.3, "Reheating as a Contribution to the Economy of the Marine Steam Turbine, with special reference to the Installation in T.S.S. 'Empress of Britain,'" A. W. Davis, 5.30 p.m.

Wed., Nov. 14th.—MERSEYSIDE AND N.W. SECTION: Technical College, Bolton, "Marine Diesel Engines," A. G. Arnold, 2.30 p.m.——SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Balancing of Marine Reciprocating Engines," B. Hildrew, 7.30 p.m.

Tues., Nov. 20th.—S. WALES SECTION: Institute of Engineers, Park Place, Cardiff, "The Carriage of Edible Oil and Similar Bulk Cargoes," J. Wormald, 7.15 p.m.

INSTITUTE OF METALS

Mon., Nov. 12th.—SCOTTISH LOCAL SECTION: Visit to the Works of British Hydrocarbon Chemicals, Ltd., Grangemouth, 2.30 p.m.

Tues., Nov. 13th.—S. WALES LOCAL SECTION: Electricity Showrooms, Kingsway, Swansea, "Fuel," C. A. J. Plummer, 6.45 p.m.

INSTITUTE OF NAVIGATION

Fri., Nov. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Navigational Aspects of Turboprop Operations over the North Atlantic," J. E. D. Williams, 5.15 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Nov. 12th.—NORTHERN CENTRE: N.E. Electricity Board's Lecture Theatre, Carliol House, Newcastle, "The Design of Agricultural Tyres and other Uses of Rubber in Agriculture," B. W. D. Lacey, 6.45 p.m.——WESTERN CENTRE: Electricity House, Bristol, "The Economics of Rural Electrification," W. J. Guscott, "Electric Motors on the Farm," B. Stocks, 7.15 p.m.

Tues., Nov. 13th.—LONDON CENTRE: 6, Buckingham Gate, London, S.W.1, "The Mechanical Properties of Soil in Relation to Basic Cultivation," P. Payne, 5.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Sat., Nov. 10th.—N.W. BRANCH: Reynolds Hall, College of Technology, Manchester, "Animal Foodstuff Plant—Some Considerations," H. Holdsworth, 3 p.m.

Wed., Nov. 14th.—MIDLANDS GRADUATES AND STUDENTS SECTIONS: Midlands Institute, Paradise Street, Birmingham, "The Transport, Storage and Handling of Hydrochloric, Nitric and Sulphuric Acids," H. Saenger, 6.30 p.m.

Fri., Nov. 16th.—GRADUATES AND STUDENTS SECTION: Caxton Hall, Westminster, London, S.W.1, "Research and Development in a Chemical-Plant Manufacturing Firm," G. A. Dummett, 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 13th.—PUBLIC HEALTH MEETING: Great George Street, Westminster, London, S.W.1, "The Effect of Synthetic Detergents on the Biological Oxidation of Sewage," L. Barden and P. C. G. Isaac, 5.30 p.m.

Thurs., Nov. 15th.—LECTURE ON THE CONSERVATION OF NATURAL RESOURCES: Great George Street, Westminster, London, S.W.1, "Metallic Corrosion and Conservation," W. H. J. Vernon, 5.30 p.m.

Tues., Nov. 20th.—ORDINARY MEETING: Great George Street, Westminster, London, S.W.1, "Allt-na-Lairige Prestressed Concrete Dam," J. A. Banks, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Nov. 12th.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "Power Factor in Industrial Installations," opened by C. F. Freeman, 5.30 p.m.

Wed., Nov. 14th.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Frequency Diversity in the Reception of Selectively Fading Binary Frequency-Modulated Signals with special reference to Long-Distance Radio-telegraphy," J. W. Allnatt, E. D. J. Jones and H. B. Law, "An Investigation of the Spectra of Binary Frequency-Modulated Signals with Various Build-up Waveforms," J. W. Allnatt and E. D. J. Jones, "An Improved Fading Machine," H. B. Law, F. J. Lee, F. A. W. Levett and R. C. Looser, "The Detectability of Fading Radio-telegraph Signals in Noise," H. B. Law, "The Signal/Noise Performance Rating of Receivers for Long-Distance Synchronous Radiotelegraph Systems Using Frequency Modulation," H. B. Law, 5.30 p.m.

Thurs., Nov. 15th.—UTILIZATION SECTION: Savoy Place, London, W.C.2, "A Self-Oscillating Induction Motor for Shuttle Propulsion," E. R. Laithwaite and P. J. Lawrenson, "Brushless Variable-Speed Induction Motors," F. C. Williams, E. R. Laithwaite and L. S. Piggott, 5.30 p.m.

Tues., Nov. 20th.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "Data Processing Equipment for Experimental Work: A Review of Techniques and Methods," opened by M. V. Wilkes, 5.30 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Tues., Nov. 13th.—Magnet House, Kingsway, London, W.C.2, "Electronic Control of Industrial Drives," E. J. P. Long, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 20th.—39, Elmbank Crescent, Glasgow, "Recent Work in the Lithgow Water Tunnel at N.P.L.," A. Silverleaf and L. W. Berry, 6.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

Tues., Nov. 13th.—BIRMINGHAM AND DISTRICT BRANCH: Exchange and Engineering Centre, Stephenson Place, Birmingham, "The Equipment and Operation of a Small H. and V. Test Laboratory," F. R. L. White, 6.30 p.m.——S.W. BRANCH: G. E. C. Building, Cardiff, "Ventilation and Plenum Design," N. F. Parry, 6.30 p.m.

Fri., Nov. 16th.—MANCHESTER AND DISTRICT BRANCH: Engineers' Club, Albert Square, Manchester, "Water Treatment for Small Steam Boilers," A. J. Rogers, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 9th.—GENERAL MEETING IN CONJUNCTION WITH THE HYDRAULICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Rotating-Beam Channel and 30in Water Tunnel at the Admiralty Research Laboratory," E. H. Lever, H. Ritter, M. Woolfson and C. T. Wright, 6 p.m.

Tues., Nov. 13th.—AUTOMOBILE DIVISION GENERAL MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Papers on Research in Automobile Stability and Control, authors from the Cornell Laboratory, United States of America, (1) "General Introduction to a Programme of Dynamic Research," William F. Milliken, jun., and David W. Whitcomb, (2) "Theoretical Prediction and Experimental Substantiation of the Response of the Automobile to Steering Control," Leonard Segel, (3) "A Device for Measuring Mechanical Characteristics of Tyres on the Road," William Close and Clifford L. Muzzey, (4) "Tyre Tests and Interpretation of Experimental Data," Albert G. Fonda, (5) "Design Implications of a General Theory of Automobile Stability and Control," David W. Whitcomb and William F. Milliken, jun., 4.30 p.m.

Wed., Nov. 14th.—N.E. BRANCH: Cleveland Scientific and Technical Institute, Middlesbrough, "Pumping Problems—Present and Future," H. Addison, 6.15 p.m.——SOUTHERN BRANCH: Polygon Hotel, Southampton, "Steam Cycles and Nuclear Power Plant," R. E. Zoller, 7 p.m.——LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Positive Displacement Rotary Engines," F. J. Coplin, 6.30 p.m.

Thurs., Nov. 15th.—INTERNAL COMBUSTION ENGINE GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "Are Diesel Engines an Interim Phase in Rail and Road Transport Development?" 6.45 p.m.——N.E. BRANCH: Stephenson Building, Claremont Road, Newcastle upon Tyne, "The Fatigue Strength of Specimens Containing Cracks," N. E. Frost and C. E. Philips, 6.15 p.m.——BIRMINGHAM AND COVENTRY A.D. CENTRES: St. Mary's Hall, Coventry, Five Papers on Research in Automobile Stability and Control, by authors from the Cornell Aeronautical Laboratory, U.S.A., 6.30 p.m.——YORKSHIRE GRADUATES SECTION: The University, Leeds, "Oil Filters and Strainers," G. G. Sharp, 6.30 p.m.

Fri., Nov. 16th.—GENERAL MEETING IN CONJUNCTION WITH THE APPLIED MECHANICS AND LUBRICATION GROUPS: 1, Birdcage Walk, Westminster, London, S.W.1, "Simulated Gear Tooth Contacts: Some Experiments upon their Lubrication and Surface Deformation," A. W. Crook, 6 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., Nov. 15th.—Geological Society, Burlington House, Piccadilly, London, W.1, "A New Process for Pneumatic Stowing: Its Development and Introduction at the Rio Tinto Mines, Spain," Edward Rich, "Some Developments in Tailing Disposal at Roan Antelope Copper Mines, Northern Rhodesia," M. R. Goldick, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Nov. 9th.—EASTERN COUNTIES SECTION: Diocesan Hall, Tower Street, Ipswich, "Automation—Does it Concern You?" Sir Water Puckey, 7.30 p.m.——GLOUCESTER SECTION: Technical College, Brunswick Road, Gloucester, "Some Aspects of Protection Processes," R. Gillanders, 7.30 p.m.

Mon., Nov. 12th.—SHEFFIELD SECTION: Grand Hotel, Sheffield, "Education and Training in Industry," W. D. Hargreaves, 6.30 p.m.——YORKSHIRE SECTION: Hotel Metropole, Leeds, "The Structure of Production Management," M. Seaman, 7 p.m.

Tues., Nov. 13th.—LUTON GRADUATE SECTION: Town Hall, Luton, "Optical Methods of Tooling," B. S. Pearn, 7.30 p.m.——BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Pattern Making," 7 p.m.——MANCHESTER GRADUATE SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, "Safety and Health in Changing Industry," E. Watler, 7.15 p.m.——DONCASTER SECTION: Danum Hotel, Doncaster, "Copying Devices and Tracer Controlled Machine Tools," H. C. Town, 7 p.m.——HALIFAX GRADUATE SECTION: Technical College, Huddersfield, "The Production of Certified Zinc Alloy Die Castings," R. Parish, 7.30 p.m.

Wed., Nov. 14th.—EDINBURGH SECTION: North British Station Hotel, Princes Street, Edinburgh, "Higher Management's Approach to Work Study," J. E. Currie, 7.30 p.m.

Thurs., Nov. 15th.—CORNWALL SECTION: Camborne School of Mines, Camborne, Cornwall, "Modern Jig Boring Technique," R. H. Reddy, 7.15 p.m.——LONDON SECTION: Royal Empire Society, Northumberland Avenue, Strand, London, W.C.2, "Automation for Batch Production," Ian Nickols, 7 p.m.——LEICESTER SECTION: Bell Hotel, Leicester, "The Education of the Production Engineer in Industrial Engineering," J. France, 7 p.m.——GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Electro-Spark Machining," G. Fefer, 7.30 p.m.

Fri., Nov. 16th.—W. WALES SECTION: Central Library, Alexandra Road, Swansea, "Computer Controlled Machine Tools," M. H. Johnson, 7.30 p.m.——DUNDEE SECTION: Technical College Hall, Bell Street, Dundee, "The Production of the Voith Schneider Propeller with particular reference to its Manufacture," A. Betts Brown, 7.30 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Mon., Nov. 12th.—Congress Hall "C," Olympia, London, "The Control and Treatment of Industrial Wastes," W. Fillingham Brown, 3 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Sat., Nov. 10th.—WALES AND MONMOUTHSHIRE BRANCH: County Buildings, Colwyn Bay, "Modern Steelwork Fabrication," G. E. Cooper, 6 p.m.

Tues., Nov. 13th.—SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Tubular Structures," R. G. Taylor, 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 9th.—Pepys House, 14, Rochester Row, London, S.W.1, Chairman's Address, "Some Aspects of Repairs to Airframes," J. C. Y. Baker, 7 p.m.

Mon., Nov. 12th.—N.W. SECTION: Engineers' Club, Albert Square, Manchester, "Some Aspects of Industrial Water Treatment," C. W. Drane, 7.30 p.m.——SHEFFIELD AND DISTRICT SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, President's Address, "Civil Maintenance and Organisation for the R.A.F. in India during World War II," J. N. Compton, 7.30 p.m.

Fri., Nov. 16th.—INFORMAL MEETING: Pepys House, 14, Rochester Row, London, S.W.1, "Semi-Conductors and their Applications," R. A. Hill, 7 p.m.

LIVERPOOL ENGINEERING SOCIETY

Wed., Nov. 14th.—9, The Temple, 24, Dale Street, Liverpool, "Experience with the Heat Pump in Great Britain," Miss M. V. Griffiths, 6 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Nov. 15th.—Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, "Some Metallurgical Aspects of Welding Non-Ferrous Metals," P. T. Houldcroft, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Nov. 9th.—Engineers' Club, Albert Square, Manchester, "The Design and Development of the 'Deltic' Engine," C. D. Carmichael, 6.45 p.m.

NEWCOMEN SOCIETY

Wed., Nov. 14th.—Science Museum, South Kensington, London, S.W.7, Annual General Meeting, "Norfolk Windmills: Part II, Drainage Mills," Rex Wailes, 5.30 p.m.

NORTH EAST COST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Nov. 16th.—Mining Institute, Newcastle upon Tyne, "Some Safety Considerations of Nuclear Power Reactors," C. D. Boadle, 6.15 p.m.

OLD CENTRALIANS

Wed., Nov. 14th.—Mapleton Restaurant, 39, Coventry Street, London, W.1, "International Exchange of Students," J. Newby, 12.45 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Nov. 14th.—11, Upper Belgrave Street, London, S.W.1, "The Manufacture of Hollow Reinforced Concrete Beams," W. K. Roberts, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., Nov. 13th.—SECTION LECTURE: 4, Hamilton Place, London, W.1, "Air Conditioning of Aircraft," E. W. Still, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Nov. 12th.—ORDINARY GENERAL MEETING: 12, Great George Street, London, S.W.1, Presidential Address, W. E. A. Bull, 5.45 p.m.

Thurs., Nov. 15th.—12, Great George Street, London, S.W.1, "Building Construction and Fire Protection," G. Langdon Thomas, 5.45 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues., Nov. 13th.—14, Belgrave Square, London, S.W.1, "The Manufacture of Phthalic Anhydride by the Fluidised-Catalyst Method," H. L. Riley, 5.30 p.m.

SOCIETY OF INDUSTRIAL RADIOLOGY

Fri., Nov. 16th.—British Institute of Radiology, 32, Welbeck Street, London, W.1, Joint Meeting with the Society of X-Ray Technologists, 7 p.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., Nov. 15th.—Park Place, Cardiff, "The Northward Attenuation of the Coal Seams in the Swansea District," S. Carey Jones, 6 p.m.

WOMEN'S ENGINEERING SOCIETY

Wed., Nov. 14th.—LONDON BRANCH: Hope House, 45, Great Peter Street, Westminster, London, S.W.1, "Engineering Training," R. G. Bellamy, Miss P. J. Wilson and Miss A. R. Chamney, 7 p.m.

Advanced Engineering Courses

Radioisotopes and Their Uses. SIR JOHN CASS COLLEGE, Jewry Street, Aldgate, London, E.C.3. Three full-time courses, four weeks each, starting Jan. 14. Fee £30.

Acceptance Testing of Electrical Equipment for Power Supply Systems. MANCHESTER COLLEGE OF TECHNOLOGY, Sackville Street, Manchester, 1. Seven lectures weekly, starting Jan. 21. Fee 30s.